Vol. 15 No. 6 June 1961

Published Monthly

OHIO STATE UNIVERSITY
JUL 6 1961

INSTRUMENT PRACTICE

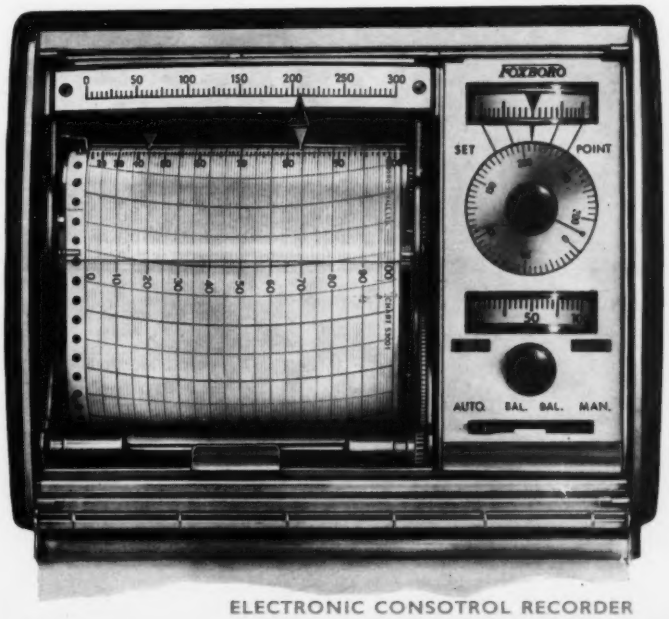
CONTROL SYSTEMS - ELECTRONICS - AUTOMATION

Electronic

CONSOTROL INSTRUMENTATION

• • • • Electronic Consotrol Instrumentation . . . a series of measurement transmitters, recorders and controllers using transistorised and magnetic amplifier designs which constitute a completely new approach to electronic instrumentation.

This development is an addition to our well established range of pneumatic control instruments for fully engineered systems of automatic control.



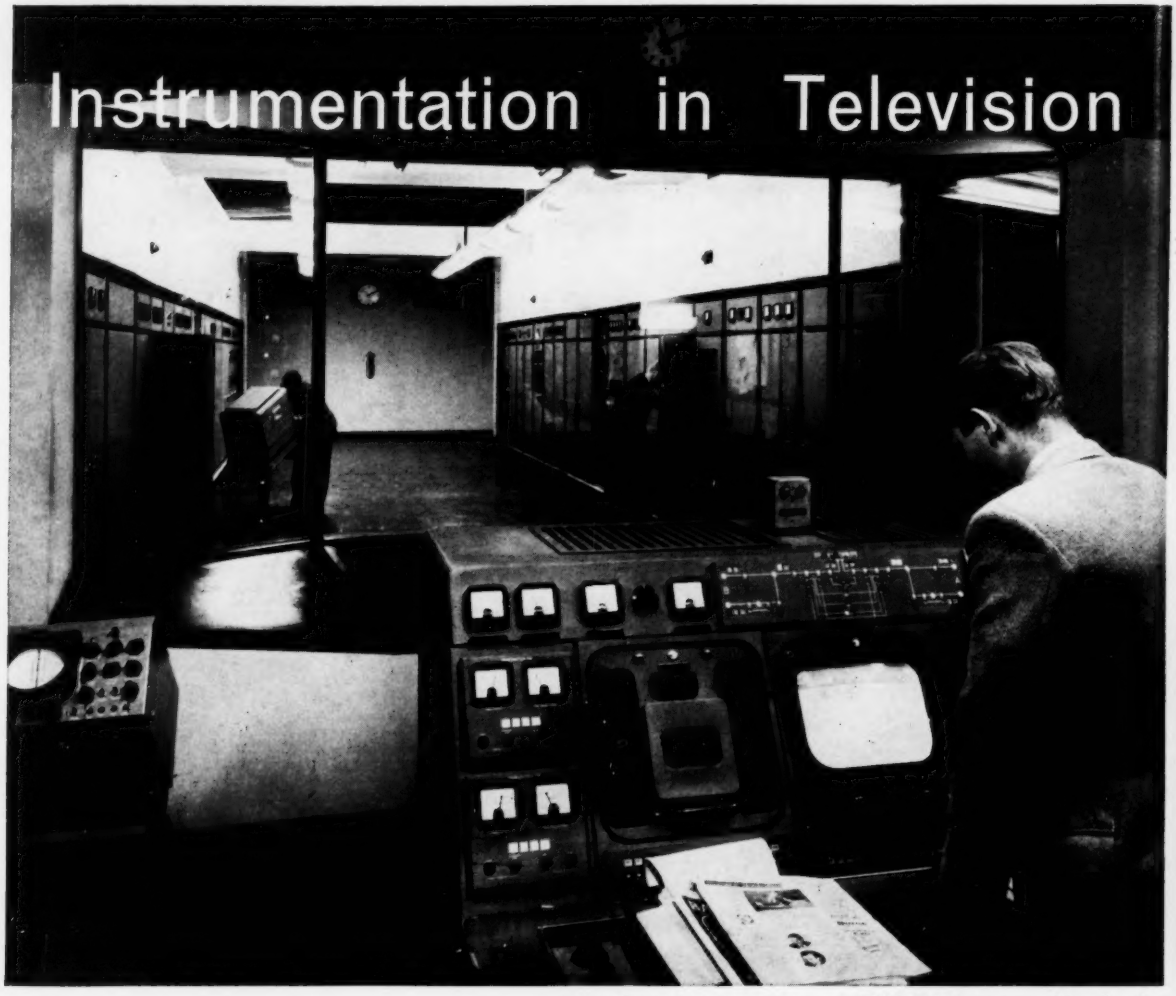
ELECTRONIC CONSOTROL RECORDER AND CONTROLLER COMBINATION

FOXBORO-YOXALL LIMITED
REDHILL • SURREY • ENGLAND

Circle 300 for further information

Circle **301** for further information

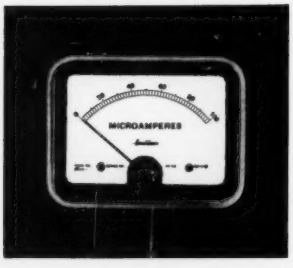
Instrumentation in Television



Ernest Turner instrumentation at the BBC Television transmitter, London.

Ernest Turner electrical measuring instruments represent the highest standards of design accuracy and workmanship. Clean lines, easily-read scales and attractive appearance combine with technical quality to present precision and industrial grade instrumentation in a wide variety of types, ranges and dimensions.

Full details of all Ernest Turner instruments are given in Catalogue No. 85, available upon request.



Ernest Turner

ELECTRICAL INSTRUMENTS LTD

HIGH WYCOMBE · BUCKINGHAMSHIRE · ENGLAND

Circle 302 for further information

DAVY-UNITED

LOADCELLS FOR WEIGHING AND LEVEL CONTROL

Where materials are used in bulk, strain-gauge loadcell weighing is unrivalled for level and process control. Remote indication and recording facilities give flexibility to every application. Davy-United loadcells are engineer-designed for simple installation and tough service — yet give consistent high accuracies up to 0.1% of maximum capacity. Our engineers, specialising in this field, are ready to advise you on applying loadcells to your plant.

Why not write or telephone for further information?

DAVY-UNITED | DAVY-ASHMORE GROUP

DAVY AND UNITED INSTRUMENTS LIMITED · SHEFFIELD

LONDON . STOCKTON . GLASGOW . MIDDLESBROUGH . HULL . PARIS . MONTREAL . MELBOURNE . SYDNEY . JOHANNESBURG . SALISBURY . CALCUTTA . BOMBAY

521

Circle **303** for further information

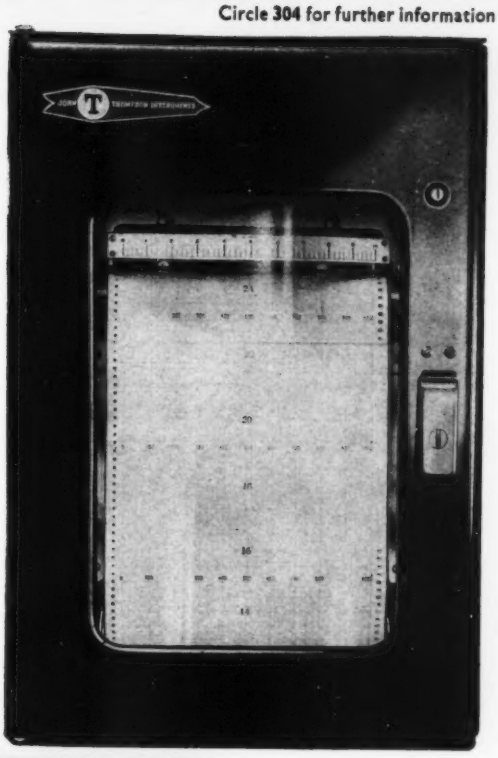
CATHODEON

THE RIGHT TYPES AT THE RIGHT TIME AT THE RIGHT PRICE

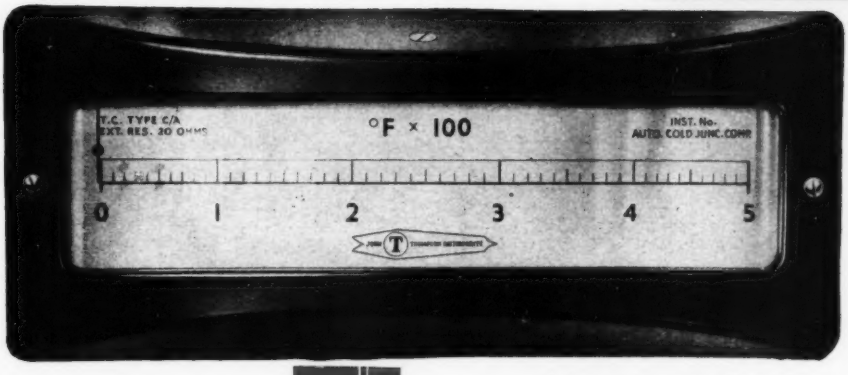
CATHODEON CRYSTALS LIMITED
LINTON CAMBRIDGESHIRE
TELEPHONE LINTON 501 (4 lines)

Circle 304 for further information

Measuring and recording temperature



and other conditions
e.g. CO_2 or *p*H



JOHN THOMPSON GROUP

FURNACE AND FOUNDRY

BOILER INSTALLATIONS

CERAMICS

SALT BATHS

CHEMICALS

Multipoint Recorder—6 in. chart
A compact and versatile addition to the Sentinel range; can indicate and record up to six different temperature (or other) conditions on a chart with each reading identified by colour and number. Twelve hours recording is always visible.
Can be supplied as a controller or for alarm setting.
This instrument can now be supplied with either Circular or Strip Chart and Photo Transistor Alarm Switching as required.

in fact . . . any heat condition in industry

Single or Multipoint Edgewise Indicator
Full 10 in. scale; can be used in conjunction with Sentinel Series Multipoint Selector Switch to indicate up to 24 points.
Can be equipped to give on/off process control or alarm indication.
Full technical particulars on application to:

JOHN THOMPSON INSTRUMENT CO LTD · WOLVERHAMPTON

MF 17

Circle **305** for further information

HOFFMANN

instrument bearings... fitted exclusively to THE MARCONI MARK IV TELEVISION CAMERA

NEW ADVANCE

Sensitivity, stability, consistency, and reliability—all are qualities of the new Marconi Mark IV television camera based upon a 4½ inch image orthicon pick-up tube.

The Marconi Mark IV has an exceptionally good performance under either natural or artificiai light, and such high stability of circuitry that a consistently high quality picture can be held without frequent re-adjustment of controls. In the B.B.C. Studio Number Three, the vision control officer is responsible for the controls of up to six Mark IV cameras. Obviously, each and all of these must be unfailingly consistent in optical and electrical performance. Equally their mechanisms must respond smoothly and instantaneously to the requirements of control. Here fourteen Hoffmann bearings play their part, ranging from $\frac{7}{16}$ to $\frac{7}{8}$ of an inch bore.

They are depended upon to give ease and smoothness of movement in such vital components as the Turret Mechanism, the Focusing Mechanism, and the Remote Iris Mechanism and Filter Kit.

HOFFMANN

BALL AND ROLLER BEARINGS

Hoffmann Technical Service is freely available; we shall be pleased to help in your next project.

BRANCH OFFICES AND STOCKROOMS IN ALL PRINCIPAL TOWNS

HOFFMANN

TELEPHONE: CHELMSFORD 3151 TELEX No. 1951

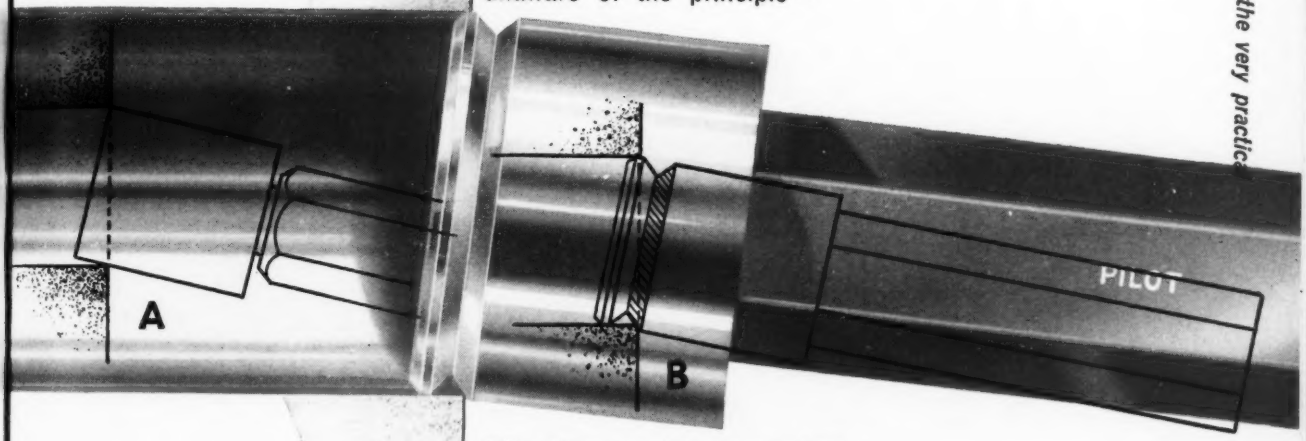
HEAD OFFICE AND WORKS: THE HOFFMANN MANUFACTURING CO. LTD., (P.O. BOX 7), CHELMSFORD, ESSEX.

Circle 306 for further information

PILOT PRACTICALITIES - 4

A series to acquaint engineers with the very practical advantages of PILOT plug gauges which reduce gauging costs.

Because a new generation of engineers has grown up since the PILOT patent for the easy entry groove was granted in 1937, many not directly concerned with gauging practice are unaware of the principle—



Why does a plain gauge jam while a PILOT "falls in"? The answer is simple. A plain gauge sticks in the hole (A) because if it is not square it jams across the hypotenuse of the triangle indicated by the dotted line. With the Pilot (B) if the gauge is not square then the chamfer of the groove (shaded dark) lifts the gauge into line with the hole and it "falls in". After 23 years the effectiveness of the Pilot lead still amazes engineers.

"PRACTICALLY" PERFECT
PLUG GAUGES

THE PILOT PLUG GAUGE CO LIMITED
SWALLOW ROAD · COVENTRY
PHONE: 87341/2

PILOT

604 Cogent

Circle **307** for further information

a calculation of mathematicians

No. 2 ARCHIMEDES

Archimedes was a mathematician and an inventor. He discovered things. He discovered that when he got into a bath full of water it overflowed and was so overjoyed that he ran down the street, without any clothes on, shouting "Eureka". The passers-by also discovered things. Archimedes invented the screw. He didn't write "The Turn of the Screw"—that was Henry James. Archimedes' screw was used for raising water. As most people are more interested in raising the wind it never went into large scale production. This explains why Archimedes didn't have to perfect a counting machine. He left it over for Counting Instruments about 2000 years later.

Archimedes wasn't the only one who went in for display. Take C.I. In-line Digital Display (most people are only too anxious to once they've had them demonstrated). Any number from 1 to 12, or any combination of letters, symbols or fractions, in white or colour can be projected on to a screen for one plane presentation. In three sizes, ½", 1" or 3½" high characters, we show here the series 640 (3½") job with a 1" standard model for comparison. Let no one say we haven't progressed in 2,000 years.

series 640

LARGE IN-LINE DIGITAL DISPLAY

COUNTING INSTRUMENTS LTD · ELSTREE WAY · BOREHAM WOOD · HERTS · Tel: ELStree 1382

ah

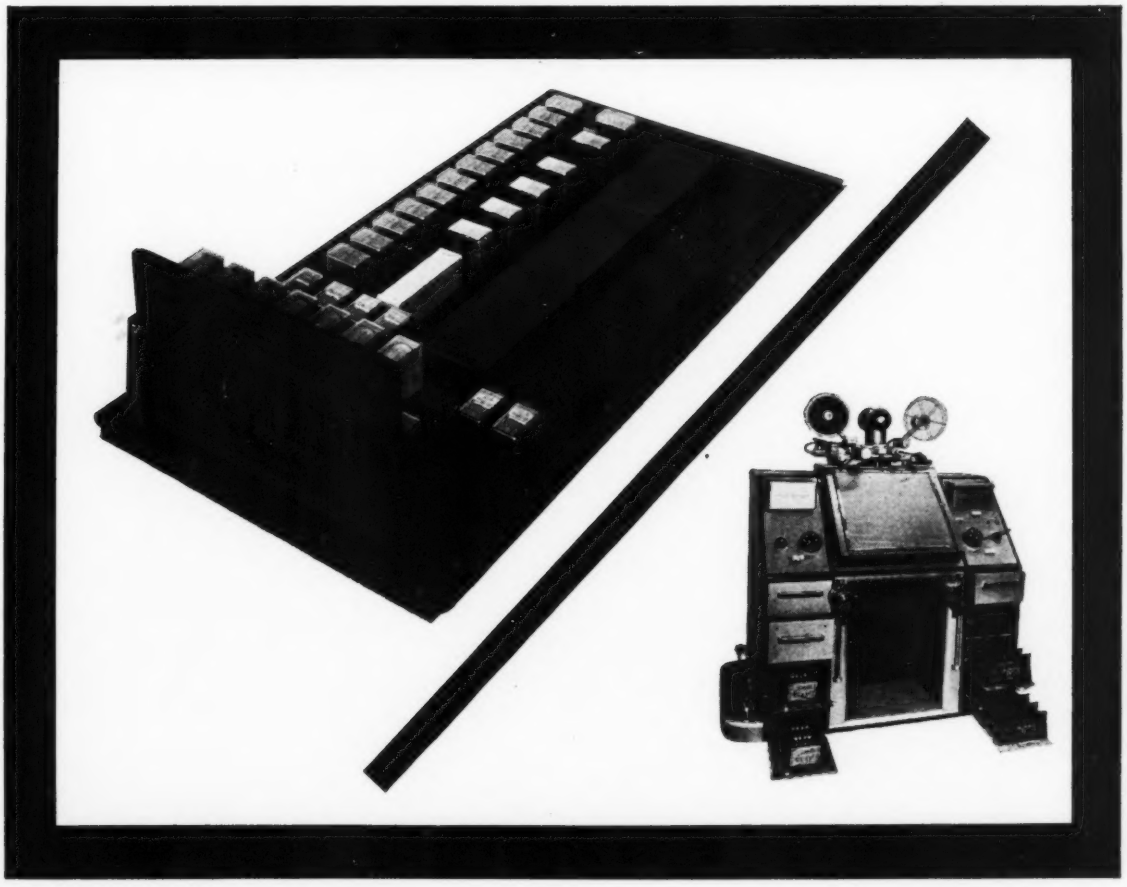
Circle **308** for further information

Take a look and you'll find...

Finest quality FORMICA Industrial laminates underlie many modern component designs. A case in point is this new film assessor designed and manufactured by Aeronautical and General Instruments Limited. The efficiency of this assessor is based on the use of printed circuits made from FORMICA double sided copper clad material. FORMICA copper clad laminates are highly dependable for this important job in the field of electronics. They are economical and require no maintenance.

You'll find FORMICA Industrial laminates in all the best of British products from the smallest radio to the largest machine. High quality is backed by an unsurpassed technical service, and Formica Limited make paper, glass, fabric and copper clad laminates, engraving material and inter-laminate prints.

FORMICA* INDUSTRIAL LAMINATES



For full information on FORMICA Industrial laminates write to:

FORMICA LIMITED (Industrial Laminates Division)

84-86 REGENT STREET, LONDON, W.1.

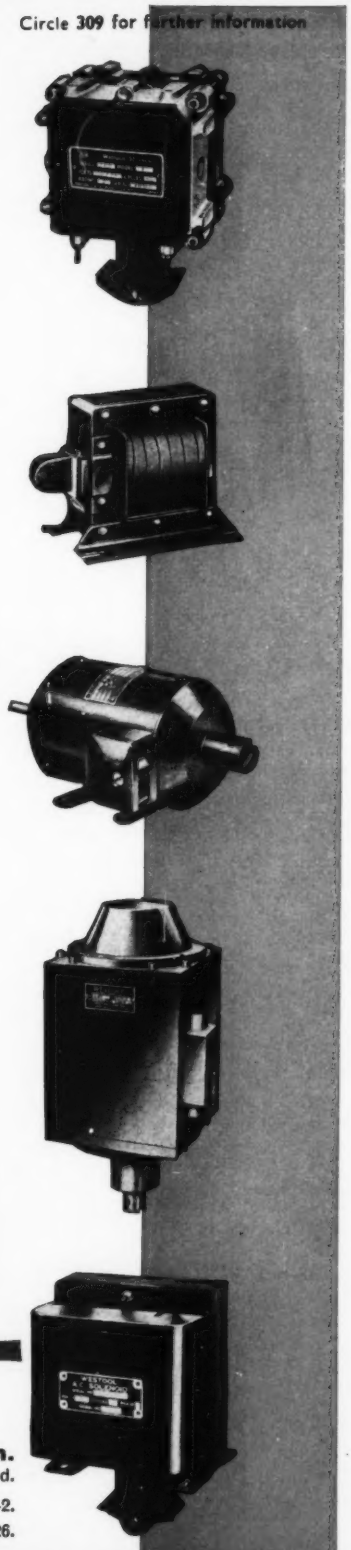
TELEPHONE: REGENT 8020

*FORMICA is a registered trademark

Circle 307 for further information

Circle 309 for further information

hopping for Solenoids



"Cynthia, darling, be reasonable; nobody told me Westool had such a whopping big range of solenoids, they simply said get Westool . . . they're so compact, utterly, utterly reliable. Seems they're tested and re-tested at every stage of manufacture. What a frightful bore! Still, I expect it's one reason why Westool solenoids are so jolly good. Steady, old girl! We shan't be long now, we've got the D.C. Pull and Thrust models, we've only to collect their A.C. Types. Cynthia—really!"

Westool solenoids, entirely self contained, can be fitted into any control system—remote, automatic or push button. Action instantaneous and certain. *Write for full technical details.*

WESTOOL

the best buy of all

WESTOOL LTD., St. Helen's Auckland, Co. Durham.
Telephone: West Auckland 551 (6 lines). Telegrams: Solenoids West Auckland.

LONDON: 2, Ashley Place, Carlisle Place, S.W.1. Telephone: Victoria 7301-2.

BIRMINGHAM: Silhill House, 2241 Coventry Road, Sheldon, Birmingham, 26. Telephone: Sheldon 5121-2.

WESTOOL LIMITED

Circle 310 for further information

A WORLD OF VIBRATION

Vibration technology is a comparatively new development in the field of environmental engineering. Its applications in measuring metallurgical stresses and strains, in simulating fatigue to destruction point, are fairly well-known, but even the present scope is far wider than these. The potential is immense to a degree which possibly outreaches that of any other applied science. It is even possible that there is much to be rediscovered, for the histories and mythologies of ancient civilizations abound in references to physical motion achieved through sound vibrations. The destruction of the walls of Jericho is an example; and it has been suggested that the Pyramids' vast masonry was elevated by similar means. But fascinating and perhaps revealing as that line of inquiry may be, this report will deal principally with the immediately practical uses of vibration testing.

From eyes to motor cars is an apt and related part of the applications range. Taking the first and uncomfortably picturesque example, an incidence of severe headaches and impaired vision suffered by transport drivers led to tests with vibration equipment. These showed that through vibration on certain road surfaces, the drivers' eyes were being literally bounced back and forth in their sockets.

MOTOR VEHICLE INDUSTRY

Car bodies and their attachments are subject to mechanical and other vibrations transmitted through suspension systems. What with wear and tear and varying concern for maintenance, the noises which can result are an age-old problem at the service station. The drumming heard by the owner 'under the back seat somewhere' is usually non-existent in normal workshop testing; out on the road it's audible but locating it is a tedious and uneconomic guessing game.

Yet further complications arise out of the fact that the vibration source may be far removed from the apparently offending component or structure.

We have a compact generator/oscillator/power amplifier combination by which all the running vibrations can be simulated *in the workshop* and the noise source accurately and quickly located. Similar equipment is used by car manufacturers so that vibrations can be compensated or designed out.

ROAD CONSTRUCTION

Roads, too, can be investigated with vibration equipment. An applied vibration is picked up at a distance, on an oscilloscope. The signal time and strength factors vary according to the nature and thickness of the surface and subgrade materials. By these readings it can be determined whether or not the construction is according to specification. Periodic tests will reveal the extent of any deterioration. In research, the behaviour of roads under various traffic conditions can be established and the information used in framing specifications for new roadworks.

AIRCRAFT INDUSTRY

In the aircraft industry, vibration testing has long been a vitally important technique. Bearing in mind the possible outcome of the failure of quite small components, vibration problems in land vehicles and structures pale into comparative insignificance. Goodmans equipment is widely used to test dynamic models . . . even whole aircraft . . . and on the multiplicity of instruments and electronic apparatus.

The tremendous power and complexity of rocket-propelled vehicles set still more-exacting requirements and for these Goodmans are producing special generators.

OTHER APPLICATIONS

The miscellany of these is far too extensive to catalogue here, but the following will serve to demonstrate the scope.

In fatigue testing, vibration generators provide wide range and prolonged consistency.

Chemical and bio-chemical research are served by our smallest generator, the V47, in mixing, emulsifying and the measurement of interface potentials. It has been used also to simulate nerve signals and to assess vibration effect on living tissue. Experiments show that physical vibration and 'white noise' have anaesthetic properties.

Vibration equipment is used in the rubber, plastic and textile industries, as an aid in establishing the materials' mechanical properties.

Experiments in the machine tool industry have shown that small and carefully controlled vibrations can, in fact, improve stock removal, surface finish and minimize the effect of certain operations upon molecular structure.

This is inherently a world of movement. Everything vibrates within itself and often as an entity. These forces can be observed, reproduced, supplemented. There must therefore be many functions for our vibration equipment which even we can only guess at . . . and even more as yet unthought of. Name your problem; consider what may be done better, faster, more economically . . . what may be done perhaps for the first time, with the help of vibration equipment. It's more than likely that the means to the end is ready-made.

Goodmans electro-mechanical vibration generators, the largest range in Europe, comprise:

TYPE	PEAK THRUST
V47	2 lb
390A	17 lb
790	35 lb
8/600 Mk.II	300 lb
VG108 Mk.II	5,300 lb
VG109 Mk.III	18,000 lb

There is available a corresponding range of oscillators and power amplifiers

GOODMANS
the vibration specialists

GOODMANS INDUSTRIES LTD. AXIOM WORKS, WEMBLEY, MIDDLESEX ENGLAND Wembley 1200 (8 lines) Cables: Goodaxiom, Wembley, England

Accredited Agents: HAWNT & CO. BIRMINGHAM · FARNELL INSTRUMENTS LTD. WETHERBY YORKS · A. R. BOLTON & CO. LTD. EDINBURGH

GD659

Circle 311 for further information

Now
Level Indication
and Control
with
1 Instrument
Remote Indicator Circuit
Alarms & Control Circuits
The
LEVELRATOR
regd. trade mark
High Level
Low Level
Levels independently adjustable
1 Electrode serves 3 operations
This instrument gives continuous indication, control, as well as visual and/or audible alarm for free flowing solids and liquids.
The instrument uses one electrode for both indication and control.
The alarm points can be set to operate over the full length of the electrode to suit the particular application.
The Electronic Dip-stick or Electrode System can be of the rigid variety for small vessels but for containers up to 60 ft. a special duty flexible type electrode is available.
By the use of the specially designed electrode system, good accuracies and near linear scales can be achieved.
Location.
The 'Levelrator' can be situated up to 150 ft. from the electrode system.
The instrument has a built-in calibrating meter.
Remote indicators can be supplied to customers' requirements and sited anywhere on plant.
The high or low level control points are completely independent of the indicating meter.
The specially designed 'Multipoint Levolog' up to 50 points, is available where centralisation of equipment is desirable.
Save Man Hours (Automatic Control)
Save Materials (Accuracy)
Save on Installation Costs
(only one controller, one electrode)
Save Money (one instrument only)
LEVELRATOR

THOMAS INDUSTRIAL AUTOMATION LIMITED

ALTRINCHAM · CHESHIRE · Tel: ALTrincham 2321/2-2339 Grams: "ELECTRONICS"

Branches: LONDON · GLASGOW · BIRMINGHAM · BRISTOL

TIA/8

Circle 312 for further information

specify H silicon junction diodes

Hughes HS10 series are low cost alloyed junction silicon diodes characterized by good forward conductance and low reverse current at high temperatures.

Made in Glenrothes, Scotland, the Hughes range of silicon and germanium diodes are subminiature devices with extremely stable electrical and mechanical characteristics. These diodes are specially designed and constructed to meet the most exacting requirements of military or commercial applications. They are double wire ended and fusion-sealed in a subminiature one-piece glass envelope to ensure complete isolation of the active elements from damage or contamination. The small size, combined with rigidity of construction and small mass of the elements, enable them to withstand successfully physical shock and vibration.

LOW REVERSE LEAKAGE + SMALL SIZE + DOUBLE ENDED + LOW CAPACITANCE + RELIABILITY + IMMEDIATE AVAILABILITY + LOW COST = HS10 SERIES

Type No.	Continuous Ratings 25°C		Characteristics 25°C		Max. Reverse Current at 100°C
	Peak Inverse Volts	Max. Forward Current	Min. Forward Current at 1V	Max. Reverse Current at P.I.V.	
HS1001	150	170 mA	100 mA	·050 μA	5 μA
HS1002	150	170 mA	100 mA	·100 μA	—
HS1003	150	170 mA	100 mA	·200 μA	—
HS1004	50	170 mA	100 mA	·050 μA	5 μA
HS1005	50	170 mA	100 mA	·100 μA	—
HS1006	50	170 mA	100 mA	·200 μA	—
HS1007	150	140 mA	50 mA	·050 μA	5 μA
HS1008	150	140 mA	50 mA	·100 μA	—
HS1009	150	140 mA	50 mA	·200 μA	—
HS1010	50	140 mA	50 mA	·050 μA	5 μA
HS1011	50	140 mA	50 mA	·100 μA	—
HS1012	50	140 mA	50 mA	·200 μA	—

Actual Size

Qualified engineers in our Research and Development laboratories at Glenrothes are available to help with your application problems.

Home and overseas enquiries to:

HUGHES INTERNATIONAL (U.K.) LTD

KERSHAW HOUSE, GREAT WEST ROAD, HOUNSLOW, MIDDLESEX · HOUNSLOW 5222

Circle 313 for further information

Stabilized D.C. power supply Type PP2

Advance laboratory-grade power supplies with their electronic protection against overload conditions and high degree of stabilization are eminently suitable for research and development work, particularly in the sphere of transistorised equipment. *Leaflet No. B105 available on request.*

- OUTPUT CONTINUOUSLY VARIABLE FROM 0 TO 50V.
- MAXIMUM LOAD CURRENT 10A.
- OUTPUT IMPEDANCE: LESS THAN 0.2 OHMS.
- RIPPLE LESS THAN 0.5MV PEAK TO PEAK.
- ADJUSTABLE ELECTRONIC CUT-OUT.
- NETT PRICE IN U.K. £220.

A brief indication of the remainder of the range:

PP1 *HT, Bias, and LT supplies for thermionic valves. Nett price in U.K. £160. Leaflet No. DB103*

PP3 *Two independent output voltages 0-30 V d.c. 1A each continuously variable. Nett price in U.K. £120. Leaflet No. DC62*

PP4 *Output voltage 0-80 V d.c. 6A continuously variable. Nett price in U.K. £220. Leaflet No. B105*

PP5 *Output voltage 0-15 V d.c. 0.5A continuously variable. Nett price in U.K. £50. Leaflet No. B102*

Advance COMPONENTS LIMITED · INSTRUMENTS DIVISION

ROEBUCK ROAD · HAINAULT · ILFORD · ESSEX · TEL: HAINAULT 4444

SBI/1

EXHIBITING at 1961 Electronics, Instruments and Components EXHIBITION · Manchester July 6-12

ETHER LIMITED

XACTROL POTENTIOMETERS

PATENTS APPLIED FOR

For the accurate measurement of TEMPERATURE · STRAIN SPEED · RESISTANCE PRESSURE · pH · FLOW CONDUCTIVITY and other variables

for indicating, recording and controlling any process variable!

FROM £126 DELIVERED

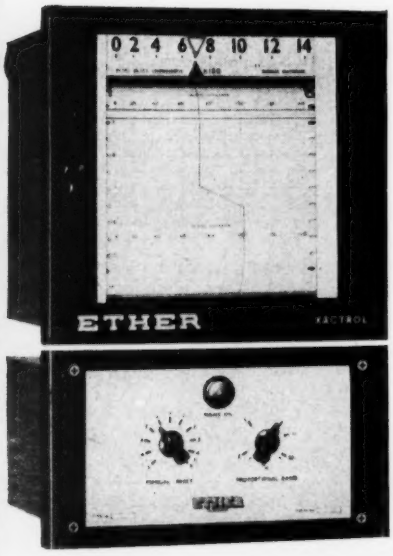
Circle 314 for further information

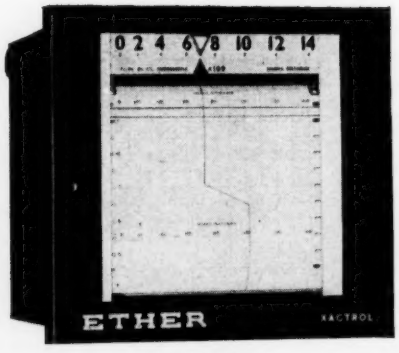
SERIES 2000
Single-point Potentiometer Recording Controllers

Type 2000: Two-position on/off control
Type 2001: Anticipatory control
Type 2002: Proportioning (electrical) control
Type 2003: Three-position control
Type 2004: Programme control
Type 2005: Proportioning (motorised) control

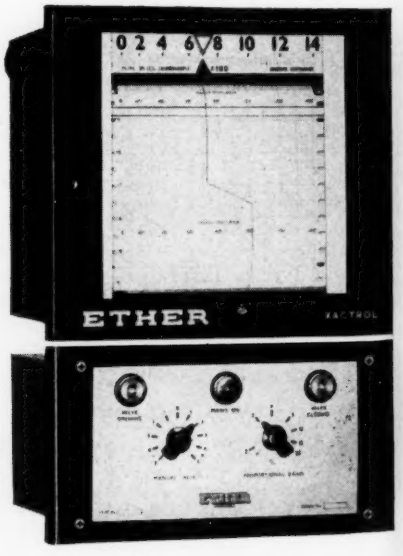
SPECIAL FEATURES:

- **Interruption of mains supply to instrument automatically shuts down furnace**
- **6" calibrated scale**
- **Standard ranges: 2mV—100mV span; other ranges to order. Changed by plug-in printed-circuit unit**
- **Standard pen speed: 2 secs. across chart; 1 sec. or 4 secs. also available**
- **Chart life: 1 month at 1 inch per hour**





Type 2000
Two-position on/off control



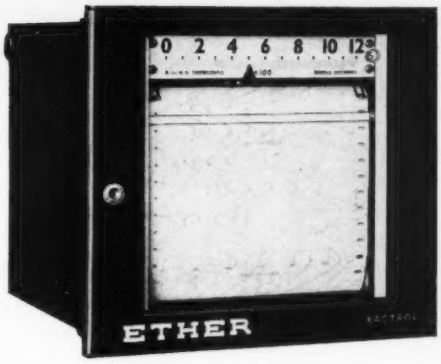
Type 2002
Proportioning (electrical) control

Type 2005
Proportioning (motorised) control

**** SIMPLICITY OF DESIGN * EASIER RANGE CHANGING***
**** EASIER SERVICING AND INSPECTION***

Circle 314 for further information

SERIES 2050
Multi-point Potentiometer Recorders



Type 2052: Two-point record

Type 2053: Three-point record

Type 2056: Six-point record

SPECIAL FEATURES:

- Balancing motor totally de-energised throughout printing and indexing cycles
- Simplified printing mechanism
- 6″ calibrated scale
- Standard ranges: 5mV—100mV span; other ranges to order. Changed by plug-in printed-circuit unit
- Pen speed: 2 secs. across chart
- Printing speed: 6 secs. per point
- Chart life: 1 month at 1 inch per hour

SERIES 2500
Single-point Potentiometer Indicating Controllers

Type 2500: Two-position on/off control

Type 2501: Anticipatory control

Type 2502: Proportioning (electrical) control

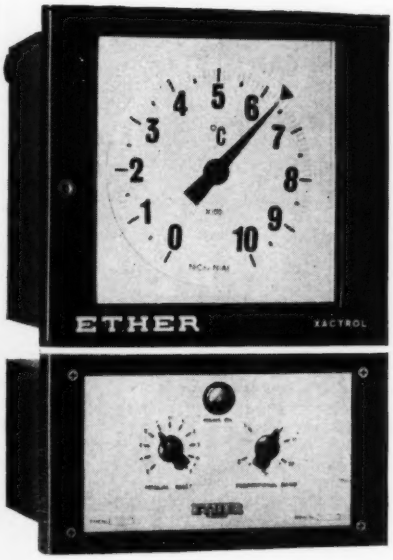
Type 2503: Three-position control

Type 2504: Programme control

Type 2505: Proportioning (motorised) control

SPECIAL FEATURES

- Interruption of mains supply to instrument automatically shuts down furnace
- 18″ calibrated scale
- Bold easy-to-read scale and pointer
- Standard ranges: 5mV—100mV span; other ranges to order. Changed by plug-in printed-circuit unit
- Response speed: 2 secs. across scale



Type 2500
Two-position on/off control

Type 2502
Proportioning (electrical) control

Type 2505
Proportioning (motorised) control

Illustrated leaflets of all 'Xactrol' Potentiometers, from: ETHER LTD.
TYBURN ROAD, ERDINGTON, BIRMINGHAM, 24 : : East 0276-8
CAXTON WAY, STEVENAGE, HERTS : : Stevenage 2110-7

ETHER LIMITED

Circle 315 for further information

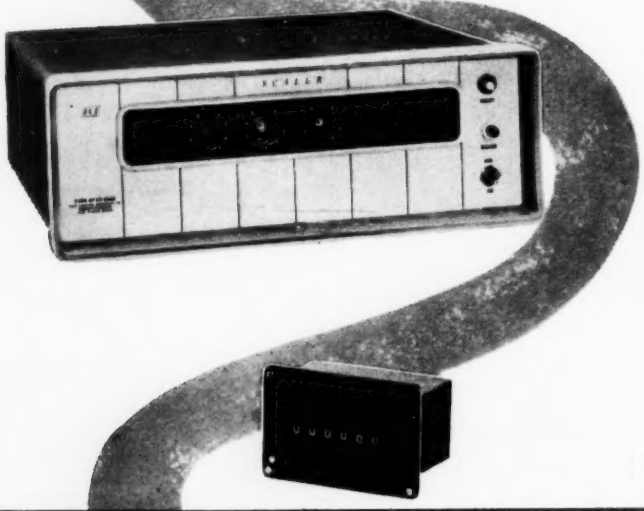
accurate measurement of liquid flow

This new range of FIRTH CLEVELAND FLOWMETER EQUIPMENT sets high standards of accuracy in the measurement of liquid flow—both for rate and total quantity.

- Flow rates from 0.25 to 300 g.p.m.
- Longscale indication of rate of flow
- Total throughput shown in digital form on electronic or electromagnetic display units
- Turbine Type Transmitter is glandless; has only one moving part.

FLOW TRANSMITTER (TURBINE TYPE)

Available in sizes from ½″ to 2″ bore. Temperature ranges of standard units from −200°C. to +160°C. Operating pressure up to 2000 p.s.i. Construction in corrosion resistant stainless steels. Used in conjunction with the F.C.I. Frequency Converter an output signal proportional to rate of flow of 0-1mA is obtained giving rate indication.



ELECTRONIC SCALER AND TOTALISER UNIT

Total flow indication by means of scaler and six digit electro-magnetic counter.

FLOW RATE INDICATOR

Suitable for flush or projection mounting. Available in dial sizes of 4″, 6″ and 8″ which can be scaled in gallons, metres, percentage of flows etc.

We shall be pleased to send you information about any or all of these units.

FCI FLOWMETER EQUIPMENT

Firth Cleveland Instruments Limited, 7 Cleveland Row, London, S.W.1. WHItehall 3100.
Works and Head Office: Treforest, Pontypridd, Glamorgan **A MEMBER OF THE FIRTH CLEVELAND GROUP**

CRC 35G

Circle **316** for further information

INSTRUMENTS OF THE FUTURE *NOW* by AVO

NEW AVO TRANSISTOR ANALYSER

A portable battery-operated instrument, suitable for testing PNP, NPN and Point Contact transistors, in the grounded emitter configuration. Provision is included for *in situ* measurements. The instrument is supplied complete with comprehensive operating instructions, together with the AVO International Transistor Data Manual which provides test data for approximately 3000 transistors.

Brief Specification:

Range of Collector Voltage:	1·5V to 10·5V (up to 150V using external supplies)
$I^{l}co$:	First indication 2μA
Base Current:	0-1 mA, 0-40 mA
Collector Current:	0-1A
Beta:	0-25, 0-250 measured at 1 Kc/s
Noise Measurement:	1-20, 21-40 dB

Construction in general conforms with U.K. Inter-Service Spec. K114.

NEW AVO VALVE CHARACTERISTIC METER Mk. IV

This instrument has been designed to test any standard receiving or transmitting valve having up to a maximum anode dissipation of 25W. Inter-electrode insulation, anode current, mutual conductance and 'gas' current can be measured, and by making a series of tests, complete families of curves may be plotted. Rectifiers and signal diodes are tested under suitable load conditions. A comprehensive data manual is supplied with the instrument, which operates from 100-120 volts and 200-260 volts 50-60 c/s A.C. mains.

Brief Specification:

Range of Anode Voltage:	12·6 – 400 volts
Range of Screen Voltage:	12·6 – 300 volts
Range of Heater Voltage:	0·625 – 117·5
Heater Current:	3A max.
Anode Current:	100 mA max.
Mutual Conductance:	0·1 – 60 mA/V max.
Negative Grid Voltage:	0 – 100V in 9 ranges
'Gas' Current:	2μA first indication

REPAIR SERVICE

Our fully equipped Service Dept. deals promptly with repairs to AVO Instruments, or if more convenient they may be sent to either of the following authorised AVO Service Agents:—

Automac Ltd., Throstle Grove Works, Gt. Egerton Street, Stockport, Cheshire.

Farnell Instruments Ltd. Light Industrial Estate, York Road, Wetherby, Yorks.

Write for fully illustrated brochures

AVO LTD AVOCET HOUSE · 92-96 VAUXHALL BRIDGE ROAD · LONDON · S.W.1

Telephone: VICtoria 3404 *(12 lines)*

A MEMBER OF THE METAL INDUSTRIES GROUP OF COMPANIES

VC/TA2

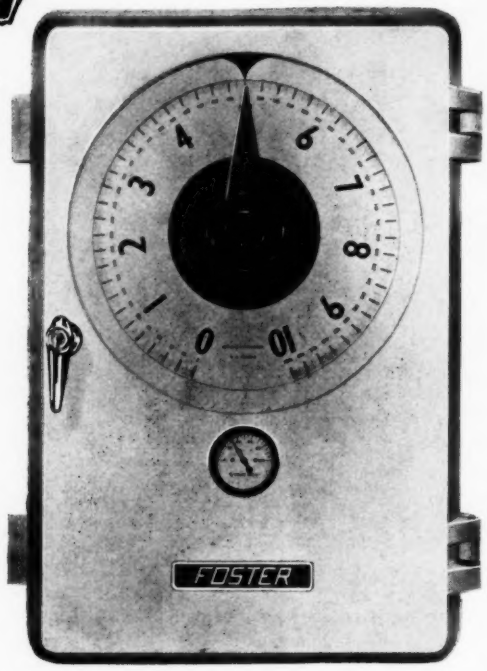
Circle 317 for further information

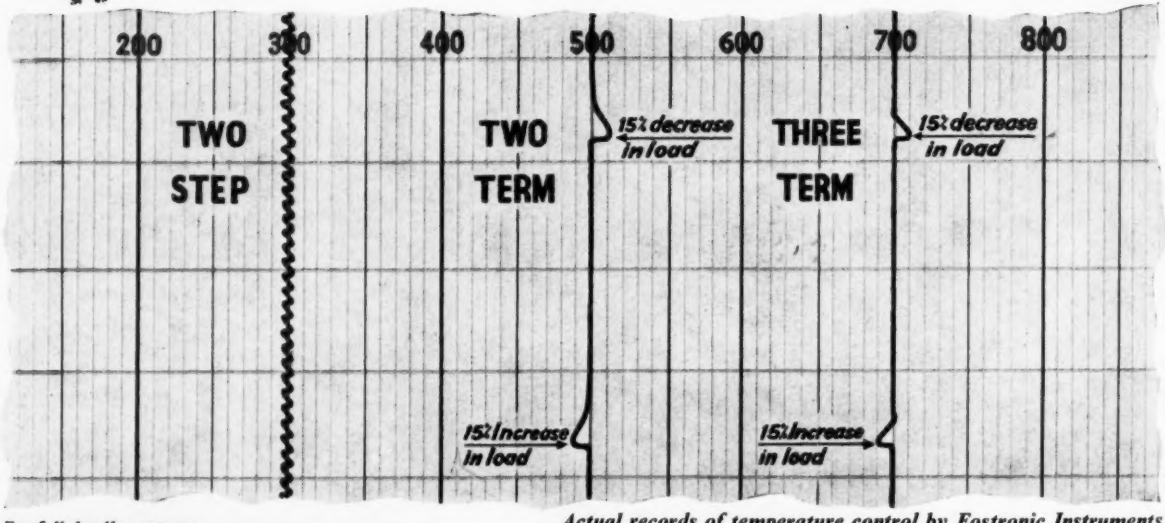
Versatility

This Fostronic Instrument is capable of measuring temperature, humidity, pH, pressure, gas constituents, etc., and of providing many modes of Control.
If you have a temperature control problem, may we help you ?

MODES OF CONTROL

- **Two Step**
- **Three Step**
- **Four Step**
- **Self Setting** (Optimising)
  Patent No. 597829
- **Attenuating**
- **Saturable Reactor** (Stepless)
- **Floating**
- **Floating Proportional**
- **Two Term**
- **Three Term**
- **Programme**





Actual records of temperature control by Fostronic Instruments

For full details contact :

RESILIA **FOSTER**

for temperature measurement and control

FOSTER INSTRUMENT CO. LTD., LETCHWORTH, HERTS., ENGLAND

Members of B.I.M.C.A.M., S.I.M.A. and S.I.R.A. *Telephone : Letchworth 984-5-6* *Telegrams : Resilia, Letchworth*

Advt/WT/24F/F

Circle 318 for further information

DRAYTON REGULATOR & INSTRUMENT CO. LTD.

ANNOUNCEMENT

The Drayton Regulator & Instrument Co. Ltd.
announce that as and from
June 1st, 1961,
the Company's name has been changed to
Drayton Controls Ltd.

DRAYTON CONTROLS LTD.

BRIDGE WORKS · WEST DRAYTON · MIDDLESEX · TEL. WEST DRAYTON 4012

DR. 12

Circle 319 for further information

TELCON METALS LIMITED

precision resistance and thermo-couple wire

TELCONSTAN is a high purity nickel and copper alloy of very low temperature co-efficient of resistance.

TELCONSTAN has a virtually constant ohmic resistance over the working temperature range (20°C to 100°C) of electrical instruments and apparatus. It also has good mechanical properties and resistance to corrosion. By reason of these physical characteristics, it is an excellent alloy, in wire or tape form, for shunts, instrument, relay and control resistors and in foil form for printed circuits.

THERMOCOUPLE TELCONSTAN is available for thermocouples and compensating cables. TELCONSTAN versus high conductivity copper can be used for the measurement of temperatures up to 350°C; with pure iron instead of copper, the range is extended to 800°C.

The following table indicates the figures normally obtained with Thermocouple Telconstan versus High Conductivity Copper, but individual requirements are supplied as required:—

Temp. °C.	Millivolts.
0	0.00
50	2.02
150	6.66
200	9.20
250	11.9
300	14.7
327	16.2
350	17.6

Cold Junction 0°C.

THERMOCOUPLE TELCONSTAN Wire is supplied in the annealed condition in all gauges.

The principal properties of TELCONSTAN are:—

Specific resistance	48 microhm cm.
Temperature coefficient of resistivity	0.000014/°C from 20-100°C
Tensile strength (annealed)	27 tons in – 2
Melting point	1250°C
Specific gravity	8.9
Coefficient of thermal expansion	0.000014/°C from 20-100°C
Thermal conductivity	0.22 watt/cm/°C

TELCONSTAN FOIL For Printed Circuits, Strain Gauges and other applications.

Thickness	Width	Weight in lbs. per 100 ft.
.001"	6"	2.30
.0008"	6"	1.84
.0006"	6"	1.38

Standard tolerance ± 10% on thickness.

TELCONSTAN RESISTANCE WIRE IS SUPPLIED IN SWG SIZES 3 to 47

TELCON METALS LIMITED

MANOR ROYAL, CRAWLEY, SUSSEX

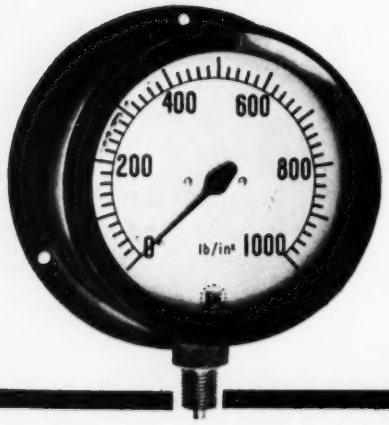
Telephone: Crawley 1560 · Telex 8748

Telegrams: Te·con, Crawley, Telex

MEMBER OF THE **BICC** *GROUP OF COMPANIES*

KDG

"K" Series PRESSURE GAUGES



Latest design and made to last, is this New Long Life Pressure Gauge by K.D.G. It is guaranteed not to have an error greater than ± 1% of the full scale deflection between 10% and 90% of maximum scale reading, the remainder of the scale being within ± 1½%. Conforming to British Standard Specifications 1780, 1960.

- Stainless Steel Mechanism.
- Heavy duty BOURDON TUBE design.
- Easy to read dial layout.
- Safety Blow-out Discs.

CRAWLEY KDG & LONDON

Full details and specifications of the complete K.D.G. range are readily available from:

K.D.G. INSTRUMENTS LIMITED

Manor Royal · Crawley · Sussex Tel: Crawley 25151

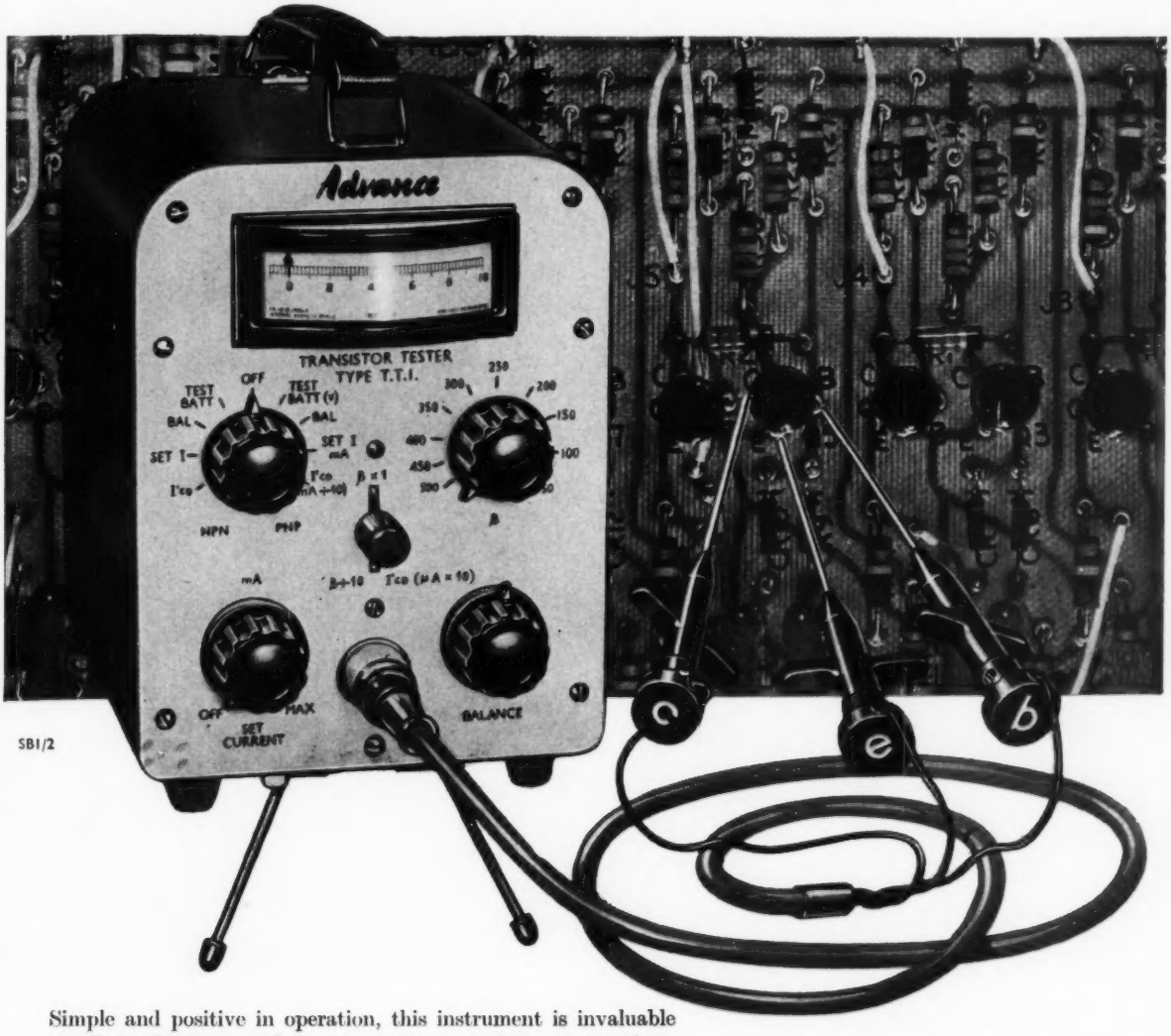
IN ASSOCIATION WITH STOW & PARTNERS LTD.

Circle 320 for further information

Circle 321 for further information

why disconnect ?

Transistors can be tested in circuit with the Advance TRANSISTOR TESTER Type TT1.



SB1/2

Simple and positive in operation, this instrument is invaluable to all development and service engineers working on transistor circuits. It is unusually compact and completely independent of external power supplies. By means of the special clip-on probes provided, the β current gain of both p.n.p. and n.p.n. transistors can be measured *without disconnecting the component from the circuit.*

Designed and engineered in the Advance tradition, the TT1 is a worthy addition to the Company's comprehensive range of test instruments and equipment.

- TESTS N.P.N. AND P.N.P. TYPES.
- BETA RANGE 5 TO 500.
- LEAKAGE CURRENT MEASUREMENTS (OUT OF CIRCUIT).
- BATTERY OPERATED TRULY PORTABLE.
- NET PRICE IN U.K. £40.

Advance **COMPONENTS LIMITED**

EXHIBITING at 1961 Electronics, Instruments and Components EXHIBITION

MANCHESTER July 6-12

INSTRUMENT DIVISION · ROEBUCK ROAD · HAINAULT · ILFORD · ESSEX · TEL : HAINAULT 4444

Circle **322** for further information

Precision

Kelvin-Wheatstone Bridge

Tinsley

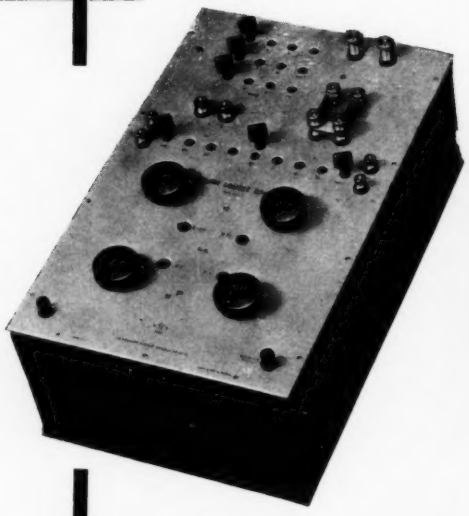
The type 4122 WS combined Kelvin-Wheatstone Bridge consists of a bridge unit and standard shunt unit mounted into one case. It is designed to cover all precision resistance measurements encountered in the laboratory.

- ★ Highest degree of accuracy with wide range of measurements
- ★ Rapid change-over from Kelvin to Wheatstone bridge
- ★ Selected, well-aged manganin coils
- ★ Patent Tinsley dual contact switches ensure very low and constant contact resistance with minimum wear

RANGES

as Kelvin Bridge : 0·1 microhm to 1 ohm
as Wheatstone Bridge : 1 ohm to 1 megohm

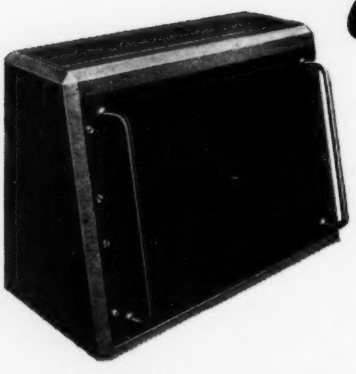
Write for List 119B for full details and specifications



Type 4122 WS

H. Tinsley & Co. Ltd.
Werndee Hall, South Norwood, London, S.E.25
tel.: ADDiscombe 6046-8

Datum "SL" Desk-Type Cases



- ★ **Removable panels facilitate mounting of meters and their routine servicing and adjustment**
- ★ **Choice of four alternative models**
- ★ **Choice of two panel angles**
- ★ **Usual Datum high standard of finish**

In spite of these star features Datum "SL" desk type cases are economically priced due to efficient quantity production. The same zinc-coated mild steel sheet and other first-class materials normally associated with Datum products are used in these cases.

Delivery is from stock.

A member of JLT GROUP

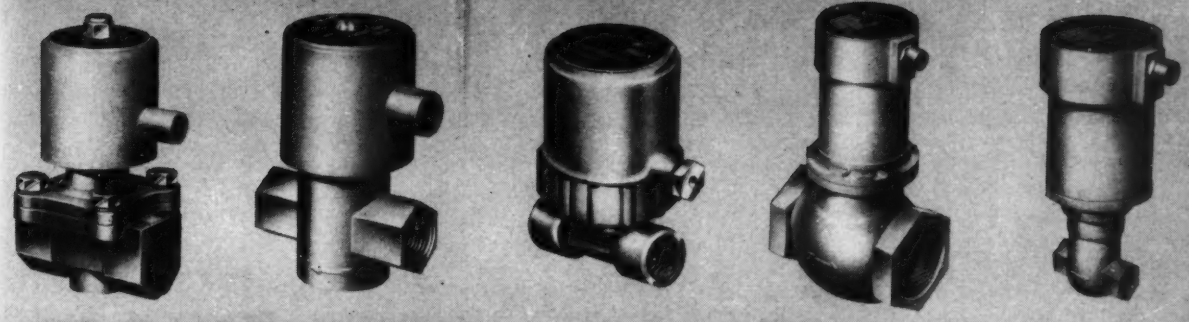
CABINETS · CASES · CONSOLES · CHASSIS UNITS

DATUM METAL PRODUCTS LTD.

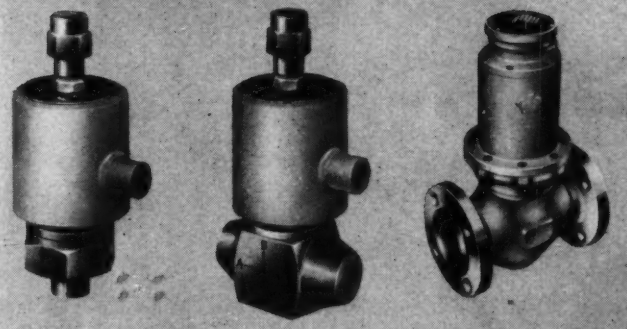
Telephone: Watford 22351
Telegrams: Datum, Watford

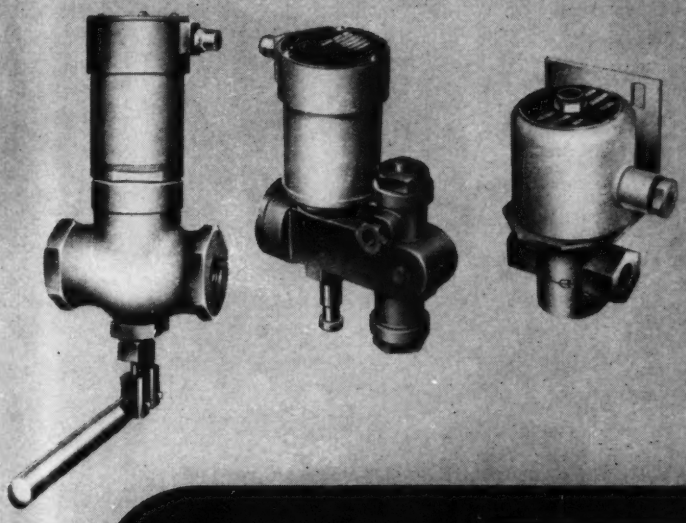
COLNE WAY TRADING ESTATE · WATFORD-BY-PASS · WATFORD · HERTS

Circle **323** for further information



For any type of SOLENOID VALVE — *whatever your need*

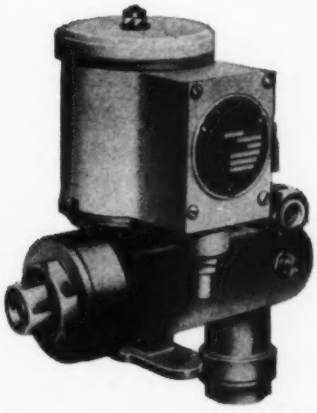




SPECIALS made to suit customers' requirements

If the solenoid valves you require are not included in our comprehensive standard ranges, our Design Engineers will gladly develop special types to suit your requirements. Whatever your need, send us your enquiries for prompt attention.

This vibration-proof solenoid valve was custom-built for use in diesel locomotives.



contact ETHER LIMITED *first!*

ETHER LTD., ***Combustion Safeguard and Solenoid Valve Division,***
CAXTON WAY, STEVENAGE, HERTS : STEVENAGE 2110–7

Only Transitron offers

Circle 235 for further information

SILICON TRANSISTORS

FEATURES

- Low I_{CO}
- High Temperature Reliability
- Mechanical Ruggedness
- Broad Power Range
- Extreme Compactness

SMALL SIGNAL

HIGH FREQUENCY (TO-18)

Type	Minimum DC Common Emitter Current Gain β	Maximum Collector Voltage V_{cb} (volts)	Typical Cut-off Frequency (Mc)	Maximum Collector Cut-off Current @ 25°C @ V_c max (μA)
2N754	20.	60.	65.	1.
2N755	20.	100.	65.	1.
2N842	20.	45.	45.	1.
2N843	45.	45.	65.	1.
2N844	40.	60.	85.	1.
2N845	40.	100.	85.	1.

INTERMEDIATE POWER

INTERMEDIATE POWER STUD-MOUNTED

Type	Maximum Power Dissipation at 100°C Case (watts)	Maximum Collector Voltage V_{cb} (volts)	Minimum DC Common Emitter Current Gain, β	Typical Collector Saturation Resistance (ohms@amps)
2N1647	20.	80.	15. @ 500mA	1.8 @ 1.
2N1648	20.	120.	15. @ 500mA	1.8 @ 1.
2N1649	20.	80.	30. @ 500mA	1.8 @ 1.
2N1650	20.	120.	30. @ 500mA	1.8 @ 1.
2N1886	20.	60.	20. @ 500mA	3.0 @ 1.

SILICON CONTROLLED RECTIFIER

TRANSITRON continues to offer the broadest line of Silicon Controlled Rectifiers in the industry. Available in five different and versatile packages, these rugged devices offer greater reliability and efficiency while replacing thyratrons, magnetic amplifiers, and other switching devices in many varied applications.

NEW 50 amp TYPE

. . . A three-terminal, four-layer device designed to control very large load currents with small gate current signals.

Type	Minimum Peak Reverse Voltage and Minimum Forward Breakover Voltage (volts)	Maximum Average Forward Current at 90°C case (amps)	Package Configuration
TCR4050	400	50	1 1/16" hex
TCR3050	300	50	1 1/16" hex
TCR2050	200	50	1 1/16" hex
TCR1050	100	50	1 1/16" hex

Type	Minimum Peak Reverse Voltage and Minimum Forward Breakover Voltage (volts)	Maximum Average Forward Current (amps) at 25°C case	at 100°C case	Package Configuration
TCR1020	100.	20.	10.	1 1/16" hex
TCR2020	200.	20.	10.	1 1/16" hex
TCR3020	300.	20.	10.	1 1/16" hex
TCR4020	400.	20.	10.	1 1/16" hex
TCR1010	100.	10.	5.0	1 1/16" hex
TCR2010	200.	10.	5.0	1 1/16" hex
TCR3010	300.	10.	5.0	1 1/16" hex
TCR4010	400.	10.	5.0	1 1/16" hex
TCR1005	100.	5.0	3.0	7/16" hex
TCR2005	200.	5.0	3.0	7/16" hex
TCR3005	300.	5.0	3.0	7/16" hex
TCR4005	400.	5.0	3.0	7/16" hex
2N1600	50.	3.0	3.0*	7/16" hex
2N1601	100.	3.0	3.0*	7/16" hex
2N1602	200.	3.0	3.0*	7/16" hex
2N1603	300.	3.0	3.0*	7/16" hex
2N1604	400.	3.0	3.0*	7/16" hex
2N1595	50.	0.6**	1.0*	TO-5
2N1596	100.	0.6**	1.0*	TO-5
2N1597	200.	0.6**	1.0*	TO-5
2N1598	300.	0.6**	1.0*	TO-5
2N1599	400.	0.6**	1.0*	TO-5

rs tomorrow's solutions today!

Circle 325 for further information

MICRO-COMPONENTS

Significant developments by Transitron in all-glass packaging have made possible the addition of new major components to what is already the broadest line of silicon miniature devices in the industry today . . .

With the introduction of all-glass packaging, Transitron now has been able to achieve TRUE hermetic sealing for its **entire** line of silicon microcomponents! . . . All units are completely compatible with present circuitry . . . All provide the same excellent performance as larger Transitron devices in 1/5th to 1/20th the space.

MICRO ZENER DIODES
(SPECIFICATIONS AT 25°C)

Type	Nominal* Voltage (volts)	Test Current (mA)	Maximum Dynamic Resistance (ohms)	Maximum Inverse Current @ E_b = —1 Volt (μA)	Typical Forward Voltage @5·0mA (volts)
TMD-01	5.1	5	15	1.0	0.75
TMD-02	5.6	5	15	1.0	0.75
TMD-03	6.2	5	15	1.0	0.75
TMD-04	6.8	5	15	1.0	0.75
TMD-05	7.5	5	15	0.1	0.75
TMD-06	8.2	5	15	0.1	0.75
TMD-07	9.1	5	15	0.1	0.75
TMD-08	10.0	5	15	0.1	0.75
TMD-09	11.0	5	20	0.1	0.75
TMD-10	12.0	5	20	0.1	0.75

*Voltage Tolerance ± 10%. For ± 5% Voltage Tolerance use "A" suffix (i.e. TMD-01A)

FAST SWITCHING

Type	Maximum Inverse Operating Voltage (volts)	Maximum Average Forward Current @ 25°C (mA)	Maximum Recovery Time (μsec)
TMD24	50	50	0.3
TMD25	100	50	0.3
TMD27	200	50	0.3

VERY FAST SWITCHING

TMD50	60	20	.004

SILICON AND GERMANIUM DIODES

- High forward conductance
- High voltage ratings
- Fast switching time
- Low shunt capacitance
- Subminiature size

SAMPLES OF THE WIDE RANGE CURRENTLY AVAILABLE:

IN914 and IN916 SILICON COMPUTER TYPES

Type	Maximum Inverse Operating Voltage (volts)	Maximum Average Forward Current @ 25°C (mA)	Maximum Recovery Time (mμsec)	Maximum Capacitance at 0 Volts (μμf)
IN914	75.0	75.0	4.0	4.0
IN916	75.0	75.0	4.0	2.0

IN695A GERMANIUM COMPUTER TYPE

(At 25°C except where otherwise indicated)	N695A
Maximum Forward Voltage Drop (volts @ mA)	0.5 @ 10
	1.0 @ 100
Maximum Inverse Current (μA @ volts)	2 @ —10
	20 @ —10*
	10 @ —20
Maximum Inverse Pulse Recovery Using JAN 256 Circuit (Recovering to 200 μA)	0.3 μsec

*At 70°C

SPECIAL PRODUCTS

In addition to a wide range of components, Transitron also offers Special Products and Devices to meet your requirements. We welcome inquiries and offer engineering advice on your particular needs.

for further information please write to:

TRANSISTORS · DIODES · RECTIFIERS · SWITCHES · REGULATORS · REFERENCES

Transitron electronic limited

BILTON HOUSE UXBRIDGE ROAD LONDON W5

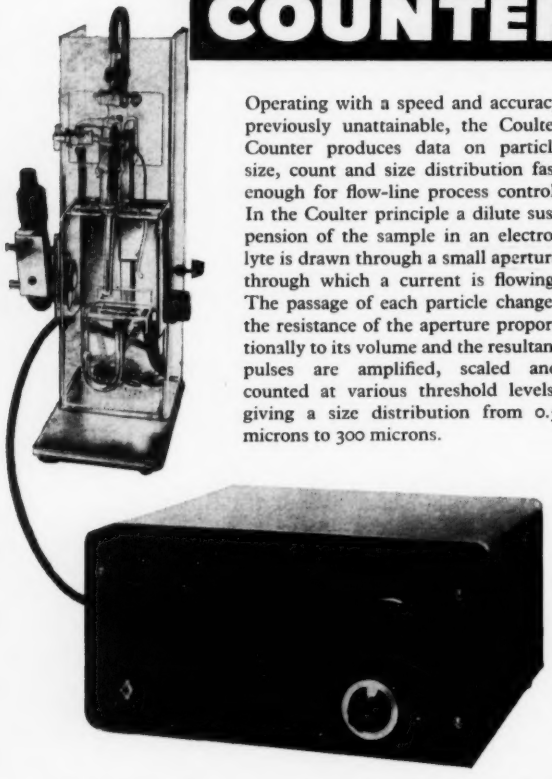
Telephone EALing 8042

Circle **326** for further information

FAT PARTICLES AND CONTAMINANTS IN MILK
•
CHOCOLATE COCOA AND SUGAR SIZING
•
BACTERIA AND YEAST CELL STUDIES

For fast and accurate particle size distribution data use the

COULTER COUNTER



Operating with a speed and accuracy previously unattainable, the Coulter Counter produces data on particle size, count and size distribution fast enough for flow-line process control. In the Coulter principle a dilute suspension of the sample in an electrolyte is drawn through a small aperture through which a current is flowing. The passage of each particle changes the resistance of the aperture proportionally to its volume and the resultant pulses are amplified, scaled and counted at various threshold levels, giving a size distribution from 0.5 microns to 300 microns.

Over 1500 Coulter Counters are already in service in industry and medicine. Full details and technical literature will be sent on request.

COULTER ELECTRONICS LTD
2-4 ASHWELL STREET,
ST. ALBANS, HERTFORDSHIRE
Telephone: ST. ALBANS 50828/9

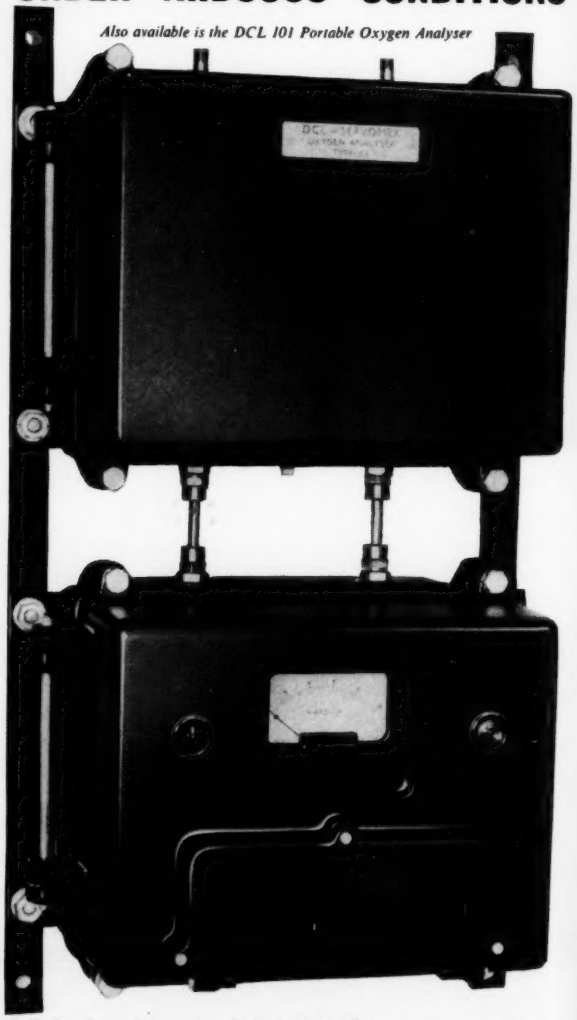
Circle **327** for further information

An all-British analyser designed specifically for arduous chemical plant service. Faraday's direct method for measuring magnetic susceptibility has been modernised to give a rapid and specific measurement free from technical snags of the magnetic wind principle. The delicate suspension is replaced by rare metal, providing a virtually unbreakable measuring system. The analyser is ideal for boiler control and chemical process use.

F.S.D. 1% to 100% in six ranges. Rapid response—95% response to input step-change achieved in 8 seconds with maximum sample flow-rate. Metal dumb-bell suspension proved against shocks of 2,000 g. Unaffected by viscosity, thermal conductivity and density, and insensitive to tilting and changes in sample flow-rate. Proved by years of plant use.

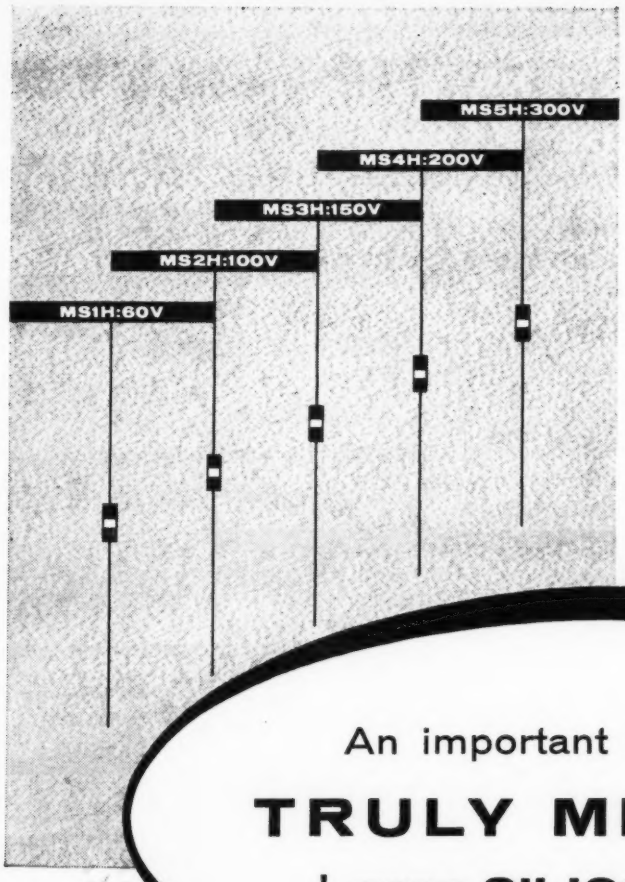
SERVOMEX DCL 83 THE MOST ADVANCED OXYGEN ANALYSER FOR CONTINUOUS SERVICE UNDER ARDUOUS CONDITIONS

Also available is the DCL 101 Portable Oxygen Analyser



Full details and expert technical advice from
Servomex Controls Ltd., Chemical Instruments Division
Crowborough, Sussex. Telephone Crowborough 1247

Circle **328** for further information



Ideal for Computer, Radar, Aircraft and other applications where miniaturisation is important

FIVE TYPES cover max. working voltages from 60V to 300V. Construction: hermetically sealed glass envelope with wire lead at each end.

An important AEI series of

TRULY MINIATURE

¼-amp SILICON DIODES

SPECIFICATION DETAILS

MINIATURE SIZE	Body only 7/64 in. dia., ¼ in. long, overall length 2½ in.
HIGH RATING	250 mA max. mean forward current
LOW LEAKAGE	1.0μA max. at 25°C at max. P.I.V.
LOW FORWARD VOLT DROP	1.0V max. at 200 mA
JUNCTION CAPACITANCE	5 pF max. at −1.0V
STORED CHARGE	20 m μ C max. (I_F=10 mA, V_R=−10V, R=1000Ω)

Please write for information Sheet EAD. 8012-1 and address enquiries to your nearest AEI Regional or District office, or

AEI

Associated Electrical Industries Limited

Electronic Apparatus Division
VALVE AND SEMICONDUCTOR SALES
LINCOLN, ENGLAND.

A5595

Circle **329** for further information

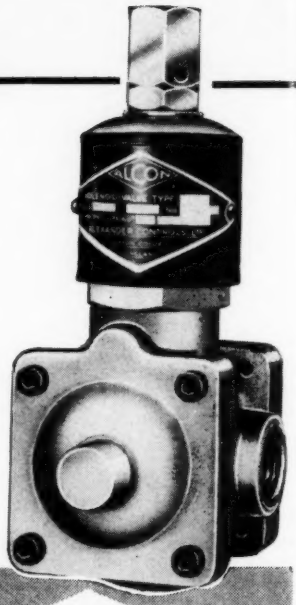
ALCON

A TIME TESTED Success Series

3 & 4 WAY SOLENOID OPERATED VALVES Types SPC3 & SPC4

For use on air up to 150 p.s.i. with full ½" bore screwed ½" B.S.P.—give rapid action of largest cylinders and diaphragms.

These valves have an electrical consumption of only 10 watts, they are capable of acting at speeds up to 300 cycles a minute. Moving parts have low inertia, giving millions of trouble-free operations.



Write for illustrated literature.

ALEXANDER CONTROLS LTD.,
Reddicap Hill, Sutton Coldfield, Warwickshire.
Telephone: SUTton Coldfield 5227-8-9

MEMBER OF THE CONCENTRIC GROUP OF COMPANIES

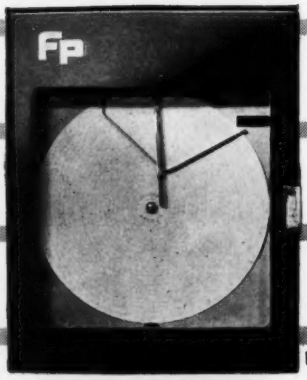
. . . FOR USE WITH
Air-operated Diaphragm & Cylinder-operated Valves

ALCON

Fp

SERIES SIXTEEN HUNDRED

FLOW RECEIVERS



* *OPERATE FROM CLOSE COUPLED . . . FLOWRATORS . . . PNEUMATIC TRANSMITTERS OR DIFFERENTIAL PRESSURE TRANSMITTERS . . .*

* **INDICATING · INTEGRATING · RECORDING · CONTROLLING**

* *WITH NOT ONLY* **ONE** *BUT* **TWO THREE** *OR* **FOUR PENS** *AS REQUIRED*

Unequalled versatility of function **PLUS** Excellent adentability to process Instrumentation

Write for further particulars:

European Export Division: *12 Koninginnegracht, The Hague, Holland.*

FISCHER & PORTER

20B, Gross Ellerhausen 73 bie Gottingen	*Kometweeg 11 The Hague*	*Workington Cumberland*
GERMANY	**HOLLAND**	**ENGLAND**

Manufacturing Affiliates of Fischer & Porter Co., Warminster, Pa, U.S.A.

FPF21

Circle **330** for further information

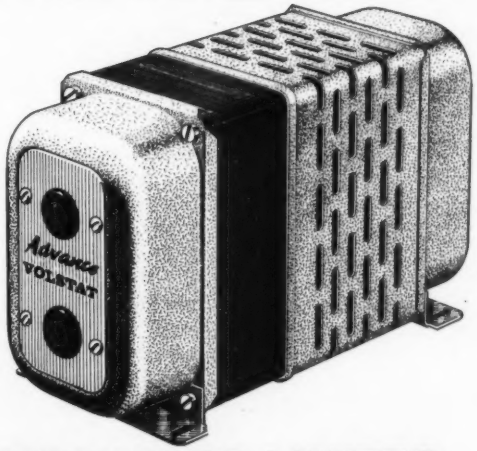
Circle 331 for further information

NOT TO WORRY

Constant voltage is assured

with a **VOLSTAT**

A VOLSTAT is the answer to many a.c. voltage fluctuation problems. In most cases, a standard type is all that is required—but there are occasions when a special design may be necessary. Either way an 'Advance' Technical Representative will be pleased to investigate your own particular problems, and recommend a VOLSTAT best suited to your needs.
VOLSTAT stands for a complete range of Constant Voltage Transformers produced by 'Advance'—the leading authority on voltage stabilization.
Full details in Folder D63 available on request.



Advance

COMPONENTS LIMITED

MAINS STABILIZATION DIVISION

ROEBUCK ROAD · HAINAULT · ILFORD · ESSEX · HAINAULT 4444

SBCV/1.

EXHIBITING at 1961 Electronics, Instruments and Components EXHIBITION · Manchester July 6-12

Circle **332** for further information

another NEW instrument

from Salford, the

minitest

POCKET-SIZED MULTIRANGE TEST SET

A new compact instrument suitable for the measurement of D.C. voltages and currents, A.C. voltages and ohms. Its high sensitivity renders it suitable for testing and fault location in all types of electrical and electronic circuits. It is well built to ensure long and satisfactory service. The instrument is economically priced and supplied with test leads with plug connections at one end. (Leather carrying case available as an extra).

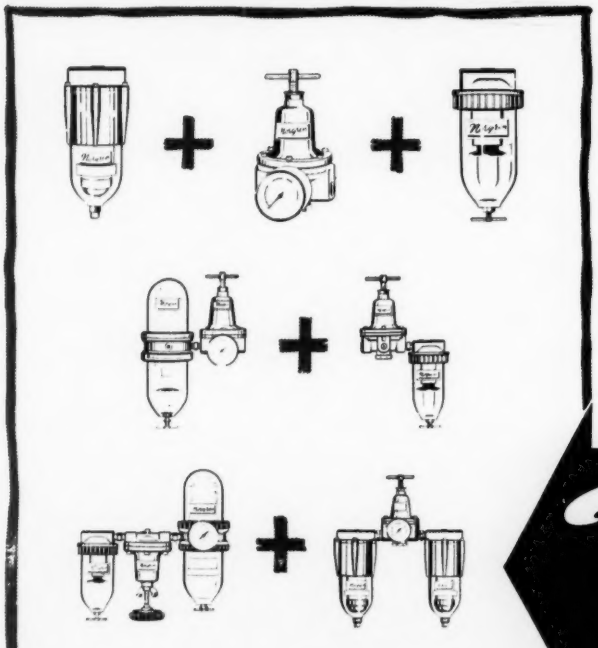
RANGES:	A.C. Volts.	2.5,	10,	25,	100,	250,	1000.
	D.C. Volts.	2.5,	10,	25,	100,	250,	1000.
	D.C. Amps.	50 μA,	1mA,	10mA,	100mA,	1A.	
	Ohms.	2000	200,000	20 MΩ			
ACCURACY:	D.C. Volts & Amps.	±2% of full scale deflection					
	A.C. Volts	±3% of full scale deflection					
		±5% at centre scale.					

Send for leaflet No. MIN/6009/IP

neat and compact . . . with large instrument performance

SALFORD ELECTRICAL INSTRUMENTS LIMITED
Peel Works · Silk Street · Salford 3 · Lancs · Tel: Blackfriars 6688
London Sales Office : Magnet House, Kingsway, W.C.2. Tel : Temple Bar 4668
A Subsidiary of THE GENERAL ELECTRIC CO. LTD. OF ENGLAND

SEI



ONE source for all your COMPRESSED AIR FILTERS and REGULATORS adds up to Norgren efficiency

Standardise with the wide Norgren range of high quality, top performance equipment, designed to meet your specific requirements, plus the advantage of one source, adding up to substantial savings in time and money. The Norgren range of Air Line Filters, Pressure Regulators and Lubricators covers every requirement—write or 'phone for full details.

Norgren

FILTERS
PRESSURE REGULATORS
LUBRICATORS

C. A. NORGREN LTD., SHIPSTON-ON-STOUR, WARWICKSHIRE

Telephone: Shipston-on-Stour 110 & 106

M-W. 135

Circle **333** for further information

Circle **334** for further information

UNIGALVO

(TYPE 45)

A galvanometer unit widely used in scientific instrumentation

AN ACCURATE 1 MEGOHM-PER-VOLT d.c. VOLTMETER

TEN RANGES are provided to cover a wide field of application.

SEALED GALVANOMETER eliminates coil stiction and loss of linearity.

HIGH STABILITY is ensured—multipliers are encased in a desiccated box giving full protection against ingress of moisture.

A CLEARLY DEFINED SPOT is presented on the scale to permit ease of reading.

ROBUST ALUMINIUM CASING with attractive durable finish affords extra protection to the galvanometer unit.

A CLAMPING DEVICE of unique design will relieve ligament tension and secure the coil when the galvanometer is not in use, thereby providing exceptional robustness.

ACCESSIBLE CONTROLS ensure ease of operation.

"EEL" GALVANOMETER SUSPENSION
TYPE A

For incorporation in test gear, bridge and potentiometric devices. Highly sensitive, sealed against dust and combining stability with robustness. Send for brochure which gives full details of this equipment.

Fuller details available from the manufacturers

EVANS ELECTROSELENIUM LTD

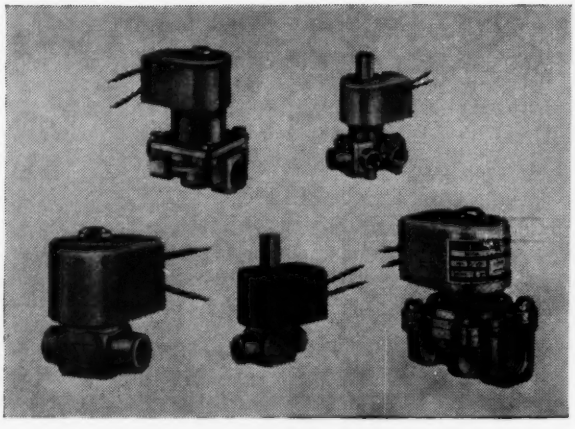
Sales Division, 93 St. Andrew's Works, Halstead, Essex
Phone Halstead 2461

SALES AND SERVICING AGENTS THROUGHOUT THE WORLD

Circle 335 for further information

Introducing

the World's most dependable SOLENOID VALVE



The world's most dependable Solenoid Valve manufactured under exclusive licence from the Automatic Switch Company of New Jersey U.S.A., by Dewrance & Co. Ltd.
To be known in Britain as Dewrance Asco, the full range covers every conceivable aspect of the Engineering Industry.

Complete technical details are freely available together with advice and recommendation on all control problems.

Dewrance Asco Solenoid Valves are available for immediate delivery at the right price.

DEWRANCE ASCO

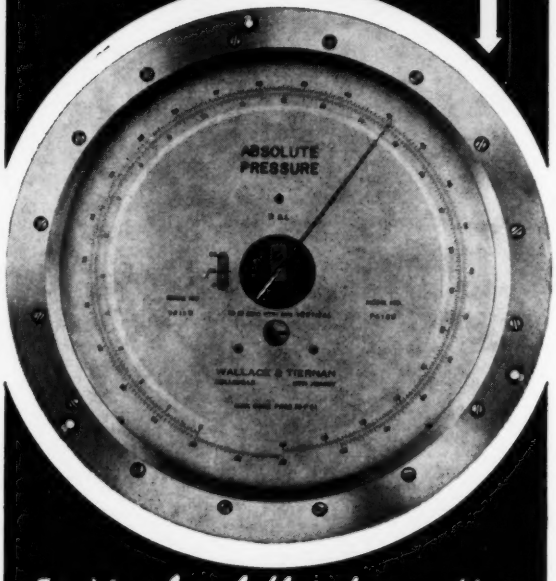
DEWRANCE & CO. LTD. GREAT DOVER STREET, LONDON, S.E.1
Telephone: HOP 3100 (12 lines)

Circle 336 for further information

FOR ACCURATE INDICATION OF PRESSURE IN THE MILLIMETRE RANGE

FA-160
RANGES—
0.1 of a millimetre to 800 millimetres

FA-129
RANGES—
800 millimetres to 50 p.s.i.a.



Write for full information

INSTRUMENT DEPARTMENT

PRECISION

WALLACE & TIERNAN LIMITED
POWER ROAD · LONDON W4
Telephone: Chiswick 7191

Circle 337 for further information

Electronic Engineering Technology

TRAIN with C.R.E.I.

WHO C.R.E.I. ARE

C.R.E.I. (The Capitol Radio Engineering Institute) was founded in America 34 years ago. It is well-known for its residential college in Washington and also for its unique procedures in offering students unable to undertake full-time study an equivalent education conducted in their own time and at their own pace. Many of the leading electronics engineers in American Industry and in the American Services are C.R.E.I. trained. At this moment over 20,000 students in the United States alone are taking C.R.E.I. home study courses.

C.R.E.I. HOME STUDY COURSES ARE NOW AVAILABLE FROM GREAT BRITAIN

In the United Kingdom C.R.E.I. home study courses have been accepted by all three Services and can be considered in appropriate cases for the part refund of fees to regular Servicemen. C.R.E.I. courses offer serious-minded students determined to further their careers the following distinct advantages:

1. Thorough step-by-step tuition by highly-qualified tutors possessing up-to-the-minute knowledge of technological development and industrial requirement.
2. Courses that are being continuously revised to keep pace with technological advancement—in this way the inevitable out-of-dateness of text books is avoided.
3. Individual tuition. The 'relationship' between student and tutor is a personal one in the sense that the student's individual requirements and progress are taken into account, throughout the course. There is no question of proceeding at the rate of a class. Your 'class' with C.R.E.I. consists of one person—you.

OPPORTUNITY is boundless — for the qualified

C.R.E.I. courses call for hard work and personal discipline, essential requirements for a successful career. C.R.E.I. qualified men are able to do more important work with accompanying rewards.

C.R.E.I. Courses are available in:

(I) Electronic Engineering Technology
(II) Mathematics for Electronic Engineers
(III) Automation
(IV) Radar
(V) Servo
(VI) Nuclear Engineering Technology

If you have at least two years practical experience in electronics or a suitable educational background, fill in this coupon now for full details of C.R.E.I. courses, methods and achievements.

TO: C.R.E.I. (LONDON), (DEPT. IP2) GRANVILLE HOUSE, 132/135 SLOANE STREET, LONDON, S.W.1.

Please send me (for my information and entirely without obligation) full details of the Educational Programmes offered by your Institute.

NAME .....

ADDRESS .....

.....

BACKGROUND EXPERIENCE .....

.....

.....

C.R.E.I. (LONDON), (DEPT. IP2) GRANVILLE HOUSE, 132/135 SLOANE STREET, LONDON, S.W.1.

Circle **338** for further information

Electrically Operated

COUNTER

AT NEW LOW COST

* Rated speed-up to 1000 Counts per minute
* Designed for panel or base mounting
* Centre reset by knob
* Connection by flying leads
* Maximum voltage 110 D.C.—250 A.C.

MODEL 442

English Numbering Machines Limited
Dept. 7H · QUEENSWAY · ENFIELD · MIDDLESEX
Telephone: HOWard 2611 (5 lines) Telegrams: Numgravco, Enfield

Full technical information on request

LEADING MANUFACTURERS OF COUNTING AND NUMBERING DEVICES

ELECTROPLATERS TO THE ELECTRONIC INDUSTRY

Specialising in **RHODIUM, SILVER, GOLD** and **HARD GOLD** plating of Electronic Components.

Vat and Barrel Plating available for Matt Silver and Bright Silver Finish, Gold and Hard Gold. Our precious metal department is at your service. Ten vans collect and deliver in London and Greater London.

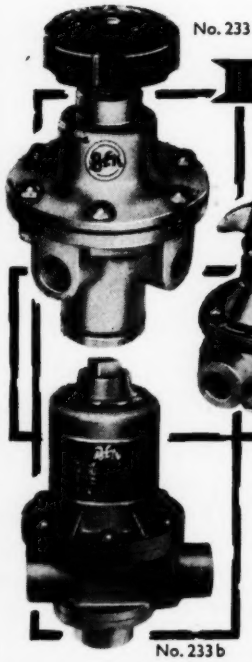
APW

ATLAS PLATING WORKS LTD.
Avenue Rd., Acton, London, W.3
Telephone: ACOrn 1102
D.G.I. & A.R.B. approved.

No. 233

B·E·N

PRESSURE REDUCING VALVES



No. 233a

No. 233b

For use in compressed air installation where it is necessary to reduce main line air pressure as required. Fitted with neoprene diaphragms to ensure long life and sensitive action.

Write for Leaflet 5/20

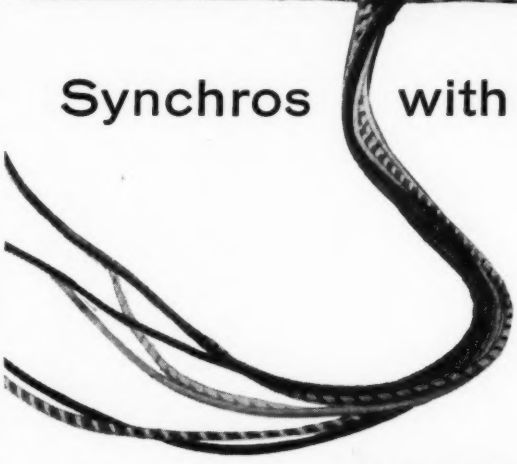
B.E.N. PATENTS LTD. (Division of Broom & Wade Ltd.)
Dept. C.2 . HIGH WYCOMBE . BUCKS.

Circle **339** for further information

Circle **340** for further information

Circle 341 for further information

Synchros with a name behind them



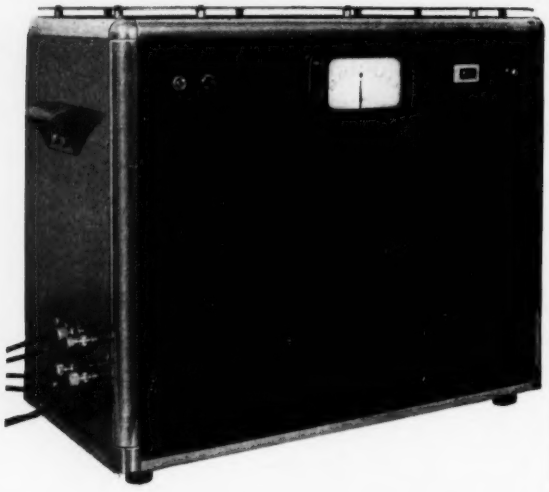
Behind Smiths Synchros and Servomotors
are the resources, the skill and the experience
of the entire Smiths organisation.
Each is a miniature marvel of precision,
performance and reliability.
The wide range of models in standard sizes
gives considerable design freedom
while special windings can be produced,
upon request. Please write for full details,
including performance data.

SMITHS

a big name in SMALL synchros

SMITHS AVIATION DIVISION KELVIN HOUSE, WEMBLEY PARK DRIVE, WEMBLEY, MIDDLESEX. *Telephone:* WEMBLEY 8888
Telegrams: AIRSPEED WEMBLEY. *Telex:* 25366. SM89

Circle **342** for further information



ELECTRONIC FLAW DETECTOR

Using the eddy current principle, the Teledictor flaw detector is a versatile instrument for use in batch or automatic production of non-ferrous tubes and sections. Imediate detection of flaws can be signalled by visual or relay method, the latter enabling completely automatic sorting to be carried out.

The unit can very simply be incorporated into automatic production lines, and a comprehensive range of coils is available. Special purpose coils and sorting equipment can be made to specification, and enquiries are invited for any flaw-detection problem.

Other equipments are also available for testing ferrous material

TELEDICTOR LIMITED

GROVELAND ROAD, TIPTON, STAFFS. Tel: 2828

Manufacturers of encapsulated coils, all types of iron-cored transformers up to 20 KVA (air cooled), soleniods, loudspeakers and specialised electronic equipment.

A Duport Company *Members of R.E.C.M.F.*

WW 63

Circle **343** for further information

these Button Lamps
are reproduced actual size.

Patents Pending

new lamps for old?

this is fact, not fable.
BUTTON LAMPS are a new departure in miniature lamp design.

because a conventional holder is not used, seven **BUTTON LAMPS** can be mounted comfortably on the area of a half-crown . . . and work!

what is more—
standard **BUTTON LAMPS** are also moulded in the latest polycarbonate materials.

another of this unique range is the **NEONETTE,** designed on the compact lines of the **BUTTON LAMP,** for mains operation.

full particulars of this remarkable range of **BUTTON LAMP** will be forwarded on request.

HUNTING ENGINEERING LIMITED

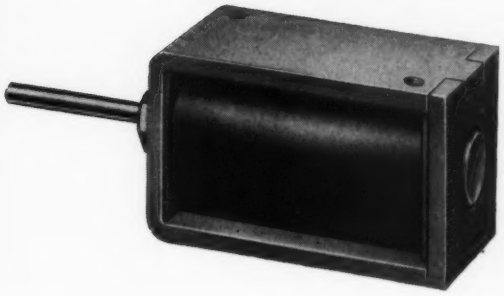
LUTON AIRPORT and AMPTHILL, BEDFORDSHIRE

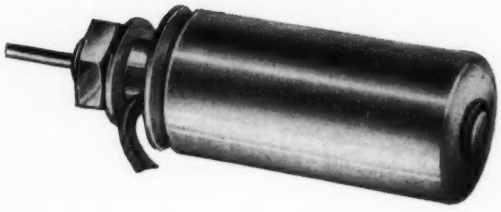
Telephone: Ampthill 3357

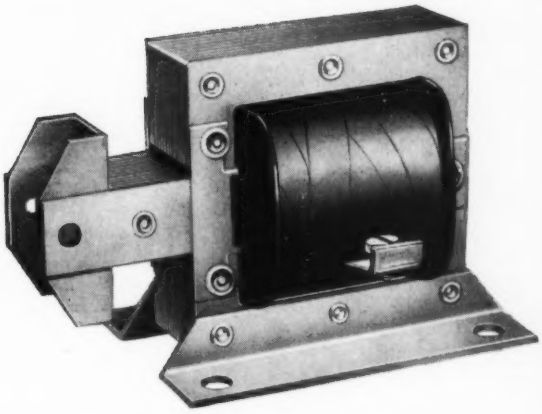
A COMPANY OF THE HUNTING GROUP.

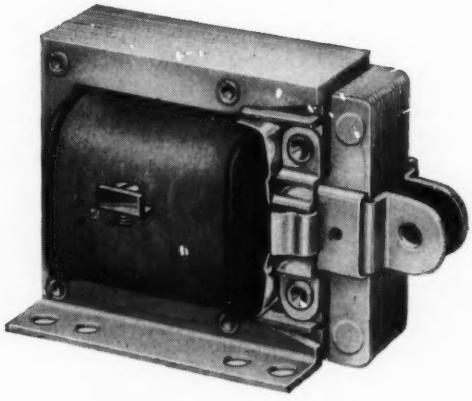
ELECTRO METHODS LTD

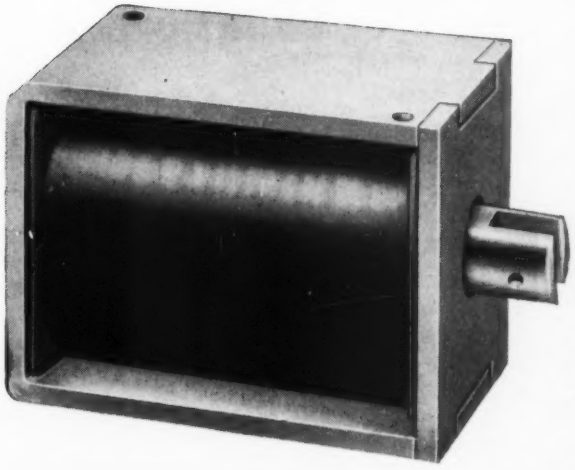
Circle **344** for further information

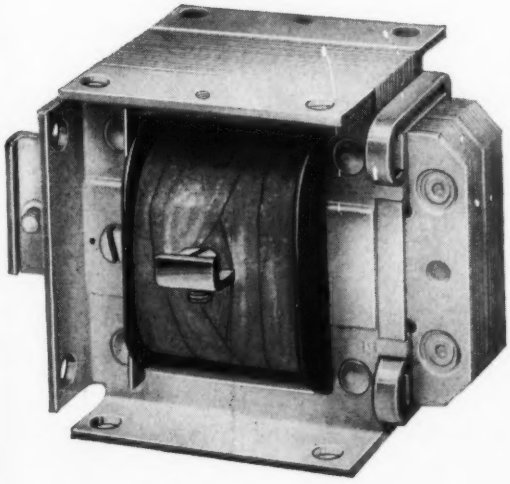












A FULL RANGE OF A.C. & D.C. SOLENOIDS

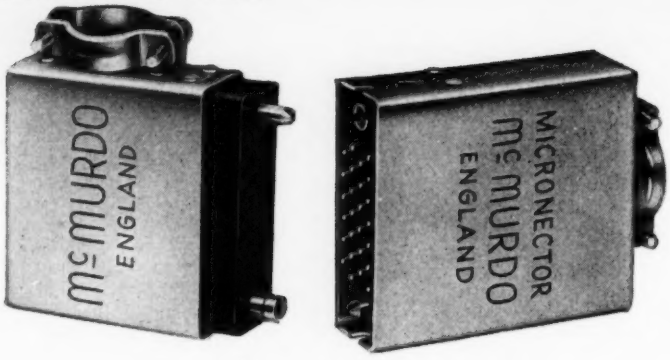
Illustrated technical data sent on request:

PROMPT DELIVERY

ELECTRO METHODS LTD., General Products Division, CAXTON WAY, STEVENAGE, HERTS.

Telephone: Stevenage 2110-7

Circle 345 for further information



9	14	18
26	34	41

50 WAYS

McMURDO MICRONECTORS

Alternative long plug cover provides pin shroud.

Strengthened extruded aluminium cover with rigid cable clamp, top or end cable entry.

Optional latch prevents accidental disengagement. Available for all combinations.

Mask to protect pins of panel mounted plug.

Gold plated sockets and pins.

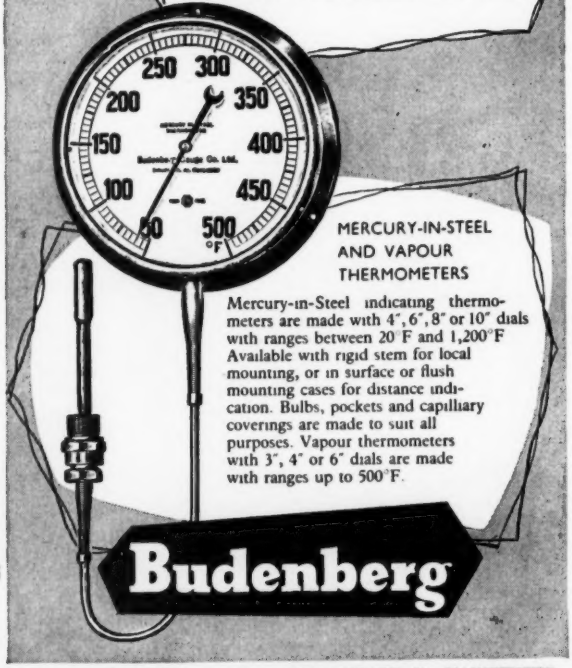
Dowels provide mechanical alignment. Special alternative dowel socket for electrical connection.

Send for full details to:

THE McMURDO INSTRUMENT CO. LTD., ASHTEAD, SURREY. Telephone: Ashtead 3401

JSP 5648

THERMOMETERS



MERCURY-IN-STEEL AND VAPOUR THERMOMETERS

Mercury-in-Steel indicating thermometers are made with 4", 6", 8" or 10" dials with ranges between 20°F and 1,200°F. Available with rigid stem for local mounting, or in surface or flush mounting cases for distance indication. Bulbs, pockets and capillary coverings are made to suit all purposes. Vapour thermometers with 3", 4" or 6" dials are made with ranges up to 500°F.

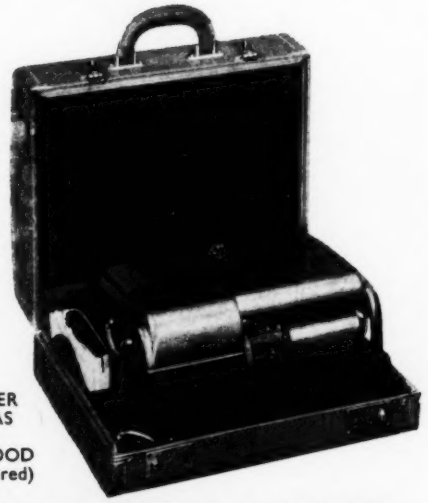
Budenberg

BUDENBERG GAUGE CO. LTD. · BROADHEATH, Nr. MANCHESTER.
London Regency House, 1-4 Warwick St., W.1. Tel.. GERrard 4822-3
Grams Pyrometer, Piccy, London. Glasgow: 62 Robertson St., C.2.

dmBU.39

'PAKAWA'

INSTRUMENT CASES



LEATHER
CANVAS
FIBRE
PLYWOOD
(Covered)

BARROW HEPBURN & GALE LTD.,
P.O. BOX 413, GRANGE ROAD, BERMONDSEY,
LONDON, S.E.1 Bermondsey 4525

Circle 346 for further information

Circle 347 for further information

Circle 348 for further information

NEW galvanometer design gives STABILITY AND ACCURACY

AETEC 8″

Thermo-electric Indicators, and Resistance Thermometers

Stability is a pre-requisite of accuracy — maintained over many years of use. The Galvanometer fitted in the new range of Negretti & Zambra Aetec Thermo-electric Indicators, Controllers and Electrical Resistance Indicators is of completely new design embodying modern techniques and materials giving high torque/weight ratio, ample gap between moving coil and magnet assembly, high sensitivity and low period.

IMPORTANT FEATURES ARE:

Accuracy guaranteed within ± ·5% of full scale deflection.
Printed circuits in Multipoint Indicators and Switchboxes to give high reliability and low cost.

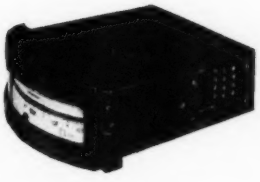
Ease of adjustment and maintenance — chassis quickly removable from anti-magnetic screening case

8-inch scale

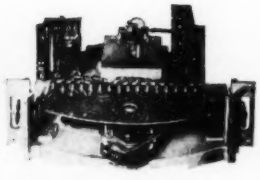
Multi-point indication — up to 5 points (thermocouple type) with built-in switch
Up to 4 points (resistance type)
Up to 24 points with external switchbox

Ranges — up to 1600°C (thermocouple type) and up to 500°C (resistance type).

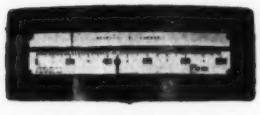
For full particulars of these outstanding instruments please write for Publication E/15 (Indicators) and Publication E/17 (Pyrometer Controllers). A comprehensive range of specialized thermocouples and resistance thermometers and other accessories is also described.
All Negretti & Zambra instruments are covered by a 2-year guarantee against defects of workmanship and materials.



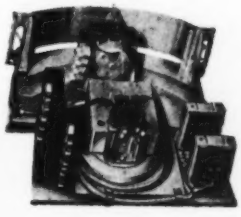
Thermocouple Pyrometer (5-point)



Interior of Electrical Resistance Thermometer (4-point)



Pyrometer Controller with red and green signal lamps



Interior of Controller

the name that means precision all over the world

NEGRETTI & ZAMBRA

Agents or subsidiaries in all major countries

Head office: 122 Regent Street, London, W.1. Telephone: REGent 3406

Works: Barnsbury, London, N.1; Aylesbury, Bucks; Chobham, Surrey; Southall, Middx. Offices at Birmingham, Cardiff, Glasgow, Manchester, Newcastle on Tyne, Leeds, Nottingham Sheffield. Repair depots at Birmingham, Leeds, Newcastle on Tyne.

Circle **349** for further information

The only journal dealing specially with

RADIO & ELECTRONIC COMPONENTS

Special Features — Exhibitions and Conferences ● Test Reports
New Components ● Manufacturers' Publications
Activities in the Industry ● Book Reviews

Some articles that have appeared in recent issues

An Analysis of Failure of Components
A. A. New, M.Sc., F.R.I.C., A.Inst.P

Precision Wirewound Resistors
D. C. F. Bartlett, B.Sc.(Eng.), M.S.M.A.

Microminiaturization, Reliable Components and Cooling Techniques
G. W. A. Dummer, M.B.E., M.I.E.E., Sen. Mem. I.R.E.

The Multi-channel Magnetic Head
C. W. Ross, A.M.Brit.I.R.E.

Potted Components K. A. Fletcher

Temperature Control for Crystal Pulling
J. I. Hopley

Protection of Electronic Equipment Against Vibration and Shock
J. A. C. Cramer, B.Sc.(Eng.)

The Phototransistor V. R. Chapler

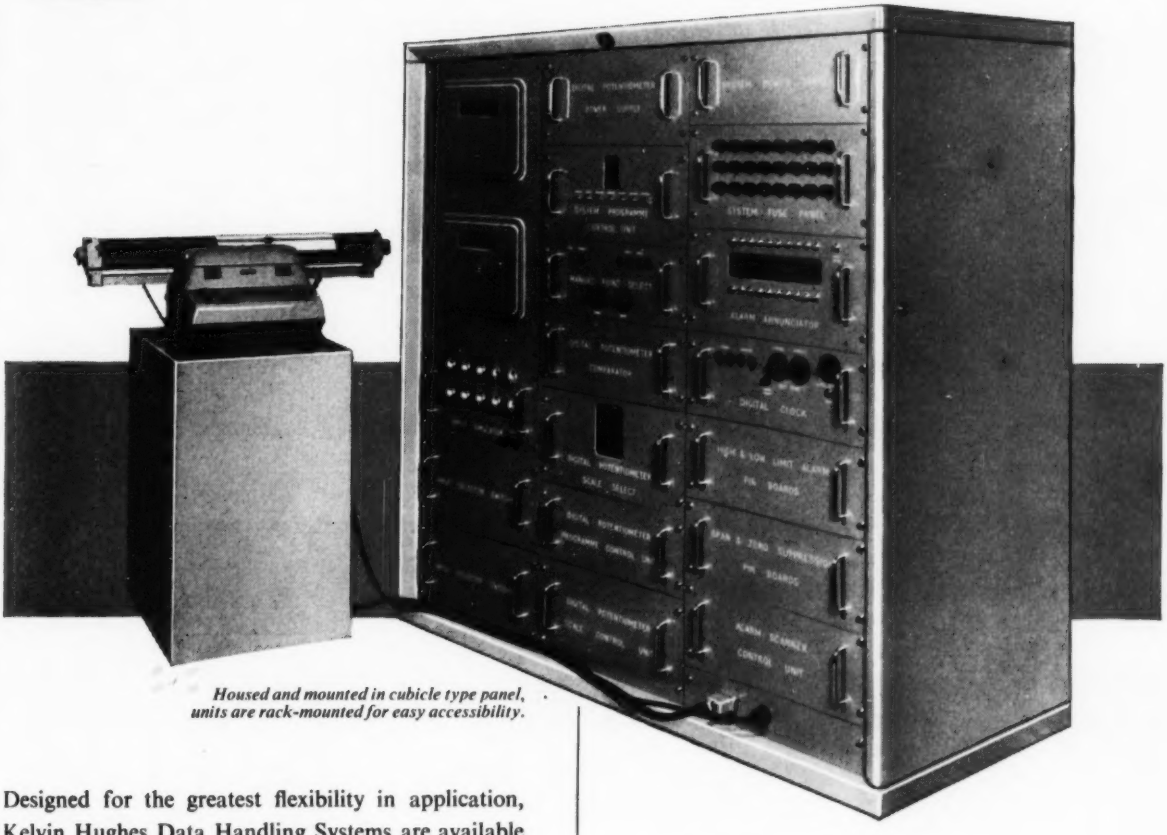
Aluminium Soldering P. W. Wright

UNITED TRADE PRESS LTD. 9 GOUGH SQ., FLEET ST., LONDON, E.C.4
Telephone: FLEET STREET 3172 (7 lines)

No limitations with

Circle **350** for further information

Data Handling systems



Housed and mounted in cubicle type panel, units are rack-mounted for easy accessibility.

Designed for the greatest flexibility in application, Kelvin Hughes Data Handling Systems are available as simple desk type monitoring units, advanced console units, or comprehensive cubicle type installations. The application potential of these systems is practically limitless, and process variables—pressure, flow, strain, pulse and a.c. outputs, etc.—can be scanned and logged at very high speed.

Smiths specialists are available to advise on individual requirements. For further details send for descriptive literature.

* Unlimited number of inputs
* Scanning time—15 inputs per sec
* Logging time—1 input per sec
* Accuracy 0.1% of reading, or 1 digit, whichever is greater
* Limit setting accuracy is 1 digit
* System sensitivity 10 microvolts (error signals of this order will be detected)

SMITHS **INDUSTRIAL DIVISION**

The industrial business of S. Smith & Sons (England) Ltd. including the marketing of industrial products under the trade marks of **Smiths** and **Kelvin Hughes**

Kelvin House, Wembley Park Drive, Wembley, Middx · Phone: Wembley 8888 · Grams: Kelhue Wembley Telex (25366)

S/KH101

Circle 351 for further information

NORMA
VIENNA

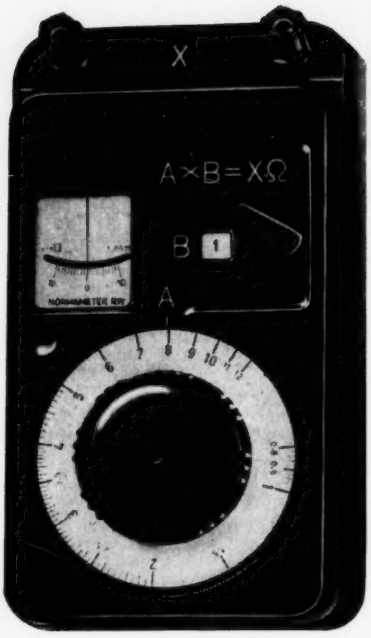
COMPACT WHEATSTONE BRIDGE

A small Wheatstone bridge suitable for general industrial use. It has a built-in 4½ volt battery for the bridge supply, and it is available with an 800 c.p.s. buzzer and earphones for conductivity measurements

*Range:— 0·08 to 60,000 ohms
16·7 to 12·5 x 10^6 micromhos

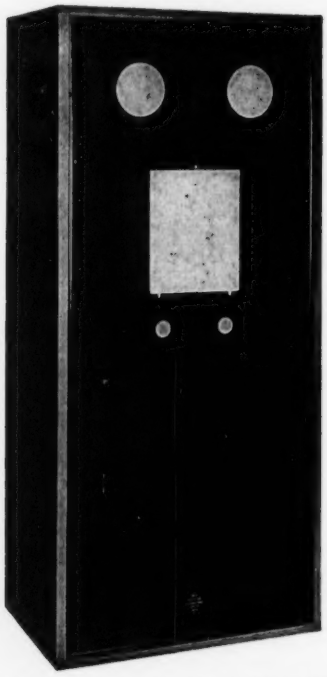
*Delivery:— Ex stock

*Price:— Bridge £15-0-0
Bridge with buzzer and earphones £23-10-0



Please request full details from Sole Agents for the U.K.

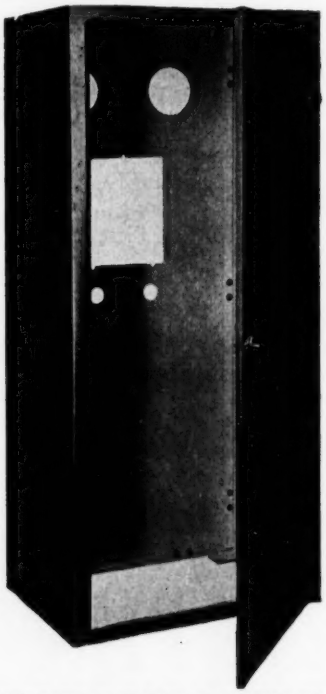
CROYDON PRECISION INSTRUMENT COMPANY
HAMPTON ROAD · CROYDON · SURREY Telephone THORNTON HEATH 4025 & 4094



NEW WESTERN

now have
The "ULTIMET" Cubicle
in production

Standardisation enables the three sizes to be offered at extremely low prices.

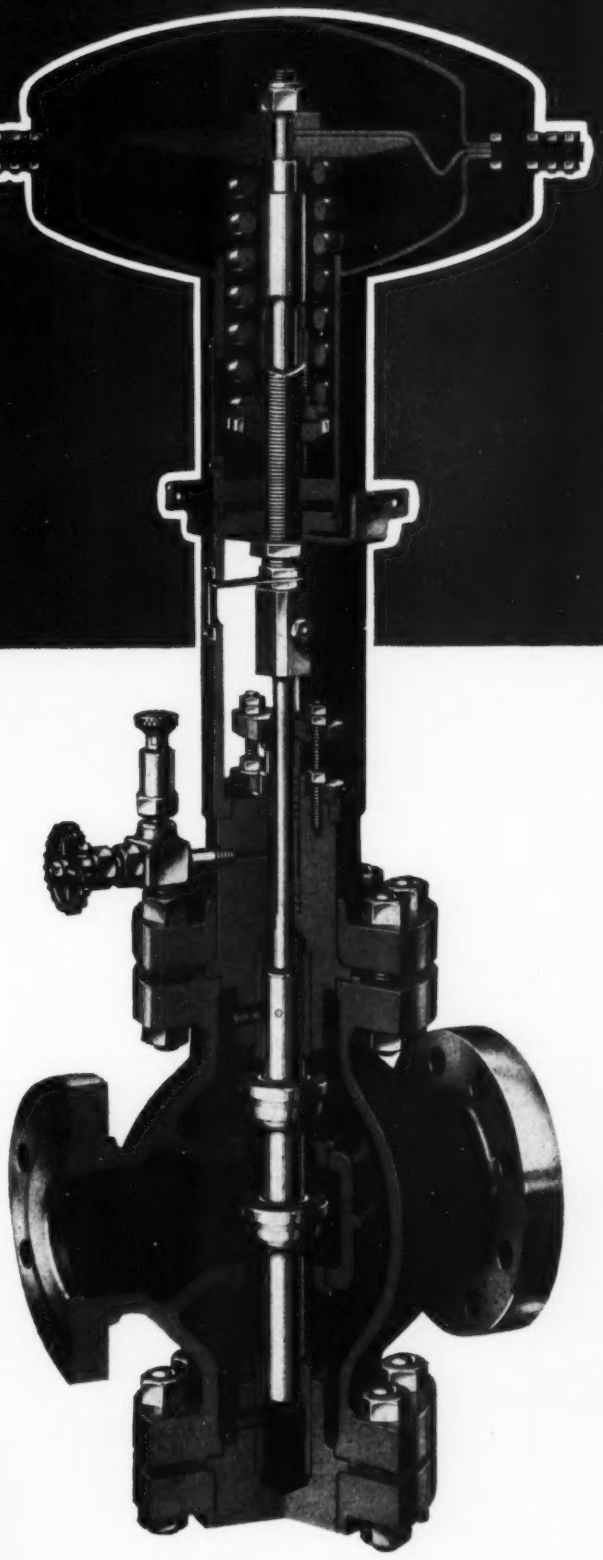


NEW WESTERN (ENGINEERING) LTD., ARGYLL WORKS, CLARENCE ROAD, LEEDS 10
PHONE 33571/2 LEEDS

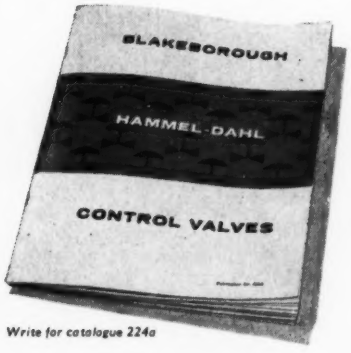
Circle 352 for further information

Circle 353 for further information

DIAPHRAGM CONTROL VALVES



Accurate, reliable, and economical these Blakeborough types do full justice to the performance of the controlling instrument—hence their widespread use on modern automatic process control systems. An advanced and comprehensive range, well worth investigating.



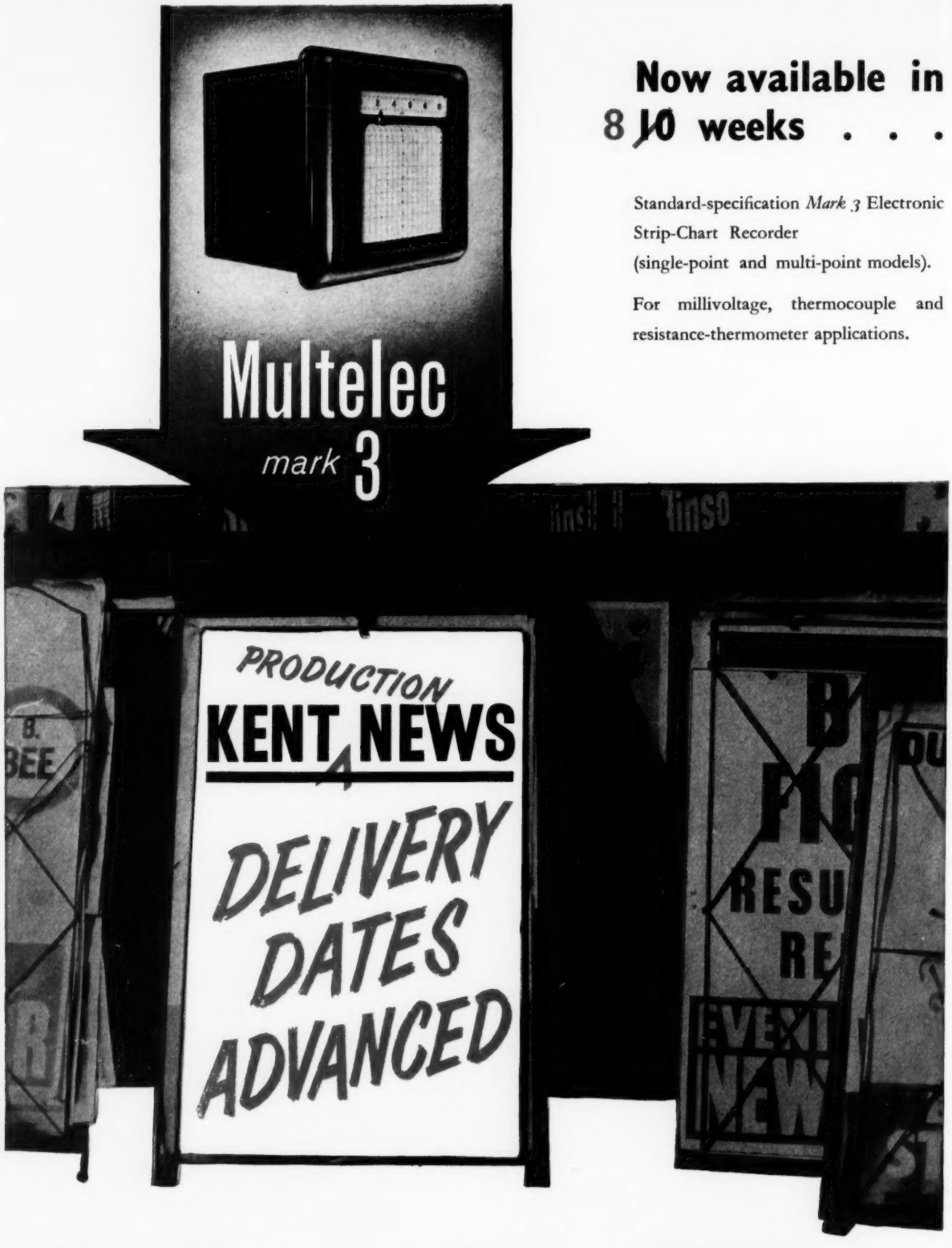
Write for catalogue 224a

BLAKEBOROUGH

J. BLAKEBOROUGH & SONS LTD · BRIGHOUSE · ENGLAND

8519

Circle 354 for further information



Now available in 8 ~~10~~ weeks . . .

Standard-specification *Mark 3* Electronic Strip-Chart Recorder
(single-point and multi-point models).

For millivoltage, thermocouple and resistance-thermometer applications.

GEORGE KENT LIMITED · LUTON · BEDFORDSHIRE
Telephone: Luton 2440 Cables and Telegrams: Kents Luton Telex
Registered Office: 199-201 High Holborn, London, W.C.1
Factories, Subsidiary Companies, Branch Offices,
and Technical Representatives throughout the world

KENT
masters of instrumentation

INSTRUMENT PRACTICE

incorporating

AUTOMATION & AUTOMATIC EQUIPMENT NEWS

Editor: J. T. Miller, B.Sc., F.Inst.P.

Assistant Editor: H. M. T. Oesterley, B.Sc.

VOL. 15. No. 6

CONTENTS June 1961

	Page
Ergonomics in Equipment Design *By B. Shackel, M.A., A.B.Ps.S.*	705
Comparison of Coefficient Data for Rough and Smooth Pipes *By R. G. West*	713
British Non-Ferrous Metals Research Association	725
Recent Trends in Industrial Flame Failure Systems *By P. R. Prior, M.S.M.A.*	726
Weather Satellite uses Infra-red Methods	731
Adaptive Control Systems *By L. A. Steiner, Ph.D.*	732
Precision and Performance	734
D.S.I.R. Road Research Laboratory Open Days	736

Regular Features

Commentary	703	News of the Industry	763
New Patents	737	Instrument Applications	771
Sima Notes	738	Manufacturers' Literature	775
New Instruments	741	Personalities	777

Published by **UNITED TRADE PRESS LIMITED**

9 GOUGH SQUARE, FLEET STREET, LONDON, E.C.4

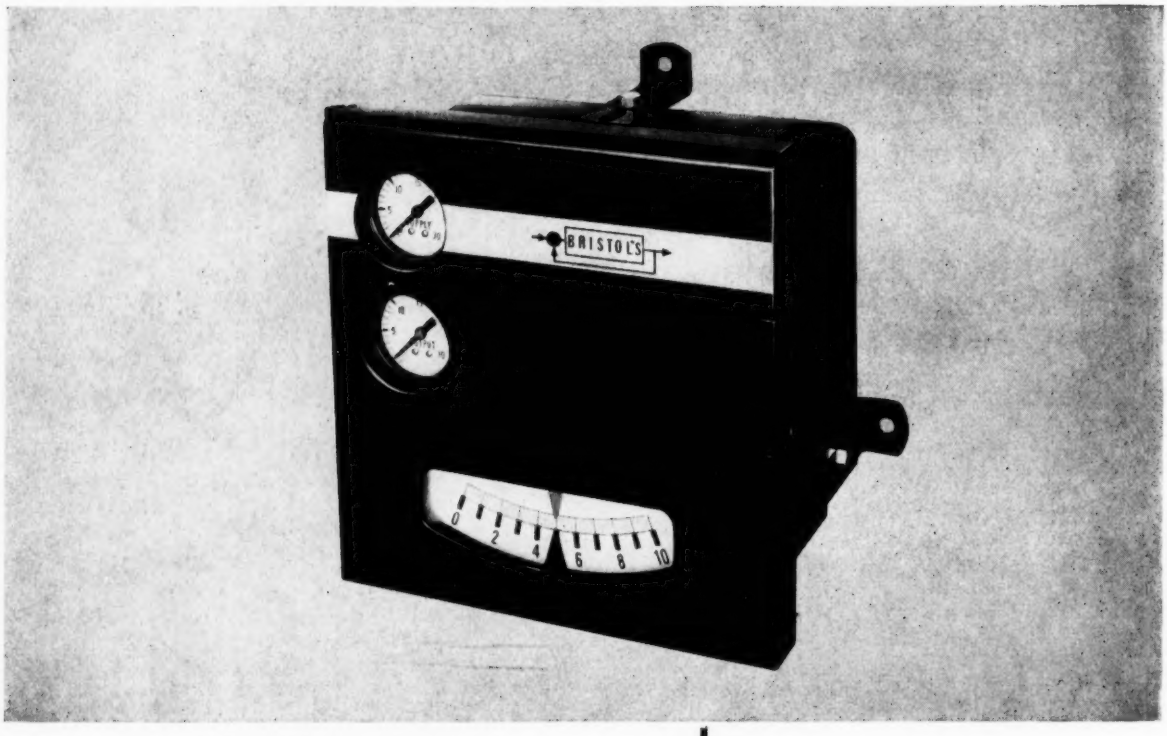
Telephones: FLEet Street 3172-3-4-5 Telegrams: MARKEBA LONDON

Technical articles will be gladly considered for publication, payment being made by arrangement. Articles should preferably be from 3,000 to 4,000 words, but no rigid limit is imposed. Manuscripts should be typewritten, in double spacing, on one side of the paper only. Diagrams should be on Bristol board, tracing cloth or tracing paper, drawn and lettered in Indian Ink, symbols to the relevant B.S. specifications. For half-tone illustrations, glossy prints are preferable. While every care is taken of MSS. submitted, no responsibility can be accepted in case of loss.

Annual Subscription United Kingdom £2-10-0, postage free. (Single copies 4/6.) $8.50 United States and Canada. £3 Sterling all other countries.

Circle 355 for further information

New advanced design indicating pneumatic controller



BRISTOL'S

SERIES 624

Highlight of this new indicating pneumatic controller is the new Bristol advanced design control unit.

It can be used with a wide range of measuring elements, and any of the standard Bristol precision measuring elements for pressure, temperature, and flow can be used with this instrument.

The control unit is made entirely of aluminium, stainless steel, Ni-Span C and neoprene. A Ni-Span C feedback bellows gives excellent ambient temperature stability.

The control unit has an efficient, compact design that is easily replaceable and can be calibrated either in the instrument or in the instrument shop.

SPECIFICATIONS

MODEL No: 624.

CASE: Cast aluminium 8″ x 8″ x 5″.

MEASUREMENTS:

Pressure—full vacuum to 10,000 psi.
Temperature—minus 100°F to +1000°F.
Flow and level—wide range with both mercury and dry type meter bodies.

CONTROL:

Proportional with 1 to 400% proportional band, direct or reverse action (Model 624B).
Proportional-plus-reset control unit. Proportional band adjustable 0-400%. Reset rate adjustable from less than 0.1 to more than 100 repeats per minute.
Proportional-plus-derivative control unit. Proportional band is adjustable 0-400%. Derivative time is from 0-10 minutes.

PILOT VALVE:

Non-bleed, high capacity. Low air consumption.

ELLIOTT

Full details from: PROCESS CONTROL DIVISION

ELLIOTT BROTHERS (LONDON) LTD

INCORPORATING BRISTOLS INSTRUMENT COMPANY LIMITED

Century Works, Lewisham, London SE13 Telephone TIDeway 1271

Members of the Elliott-Automation Group

PCD1

INSTRUMENT PRACTICE

COMMENTARY

N.P.L. 1960 The National Physical Laboratory Report for 1960 has just been published (H.M.S.O. 9s. 2d. net, 10s. 2d. post free). This is always an interesting report to read, but it is particularly significant for our readers in view of the wide range of measurement and control systems which enter into most of the Laboratory's investigations. The majority of the latter are fundamental in nature and involve, therefore, considerable original instrumentation. In view of the length of the report (some 176 pages) it is only possible to select certain items for discussion, but these it is felt will illustrate the work of the Laboratory.

In these days, the introduction of a single word—coined or otherwise—instead of a phrase to describe a particular field of activity is exceedingly popular. The N.P.L. has followed the fashion and the title of the Control Mechanisms and Electronics Division has been changed to the Autonomics Division. The word it is suggested describes the science of self-organising systems, systems intrinsically capable of improving their own performance. Actually, the work carried out by the department, covers a wider range than might be indicated by the new title. Broadly, the problems investigated come under the headings of very high speed computing techniques, mechanical translation of foreign languages into English, automatic recognition of characters in print and adaptive control systems. In high speed computing techniques, the replacement of semiconductors by metallic films has received some attention. Varieties of these have already appeared in in the United States and a typical alloy used is 80-20 Ni-Fe plated on to a suitable base. The films are of the order of 5,000 Å or less thick. Still more attention appears to be devoted to planar cryotrons, i.e. a component utilising the effect of super conductivity at liquid helium temperatures. This device gives promise of higher speeds, greater reliability, and smaller size for computers of the future, but will obviously take some time to appear in industrial forms.

" The number of scientific journals in the world increases exponentially with time; so does the need for their translation ".

One is aware of course, of the apparantly unlimited number of new publications appearing but it is a shock to learn that the law of growth is an exponential one. Joking apart, the increase has involved the Laboratory in serious translation problems and any mechanical device which can perform a translating function is to be welcomed. Work has proceeded in the Division on the preparation of an automatic Russian-English dictionary to be operated on the ACE computer.

Pattern recognition is another major problem in hand in the Autonomics Division. Commercial models of involving recognition have already appeared, but what concerns the Division is recognition of printed characters regardless of fount and hand written characters. The report states that it has gone some way towards the solution of recognition of hand written and printed numerals.

In the adaptive control field, the problem of optimal control has been attacked from a number of aspects and it is felt that not only in this sphere, but in control generally, much benefit may be derived from the study of men and animals as control systems. It is pointed out that both are capable of accurate control without the detailed mathematical analysis which has been applied to the design of purely deterministic control mechanisms.

As a contrast to autonomics one might mention the subject of measurement of high pressures. The pressures involved here can reach many thousands of atmospheres e.g. 100,000. Conventional methods are of little use, and it is necessary to examine other physical phenomena. For example, the resistivity of semiconductors varies with pressure. A graph in the section devoted to the Basic Physics Division shows that the resistivity increased, for indium antimonide, from about 10^{-2} ohm cm at low pressures to about 10 ohm cm at 30,000 atmospheres, the temperature being 293°K. Above this value there is a sharp fall attributed to the change from semiconductor to metallic behaviour on melting. Another effect with the same semiconductor is the variation of melting point with applied pressure giving an apparently linear relation.

One other investigation may be mentioned to indicate the instrumentation interest. The rectifier moving coil instrument has many advantages but is not suitable for precision a.c. measurements because its indications are proportional to the mean and not the r.m.s. value of a signal. A rectifier circuit is being designed to respond accurately to the square of the applied voltage. It is anticipated that an instrument will be evolved which will compare in accuracy with a precision dynamometer but will require a much lower power input.

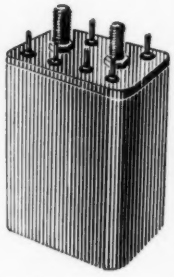
Circle 356 for further information

Plessey

relays . . .

MINIATURE TYPE CA

Fully Type Approved to RCS 165 and 166.
Light and medium duty types have two changeover contacts.
Heavy duty types single make or break.
Available sealed, or unsealed with dustcover.



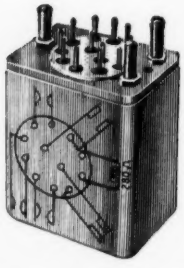
MINIATURE TYPE CB

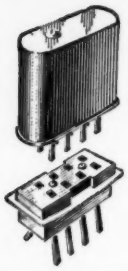
Based on Type CA with heavier magnetic circuit.
All versions fully Type Approved.
Available with up to twelve springs.
Twinned platinum contacts on light duty versions.
Available sealed, or unsealed with dustcover.

MINIATURE TYPE CC

Meets RCS 165 and MIL-R-5757 Specifications.
Based on Type CA magnetic circuit, providing up to four light or medium-duty contact sets.
Available sealed, or unsealed with dustcover.
Printed circuit versions available.

Contact loadings up to 10A d.c., non-inductive, can be arranged for Types CA, CB, and CC.



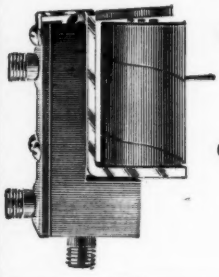


SUB-MINIATURE TYPE CE

Occupies less than ¼ square inch of chassis area.
Two changeover contacts rated 0.25A at 28 V d.c.
Insulation proof against 500 V a.c., r.m.s. between coil and contact stack.
−55°C to +100°C operational temperature range.

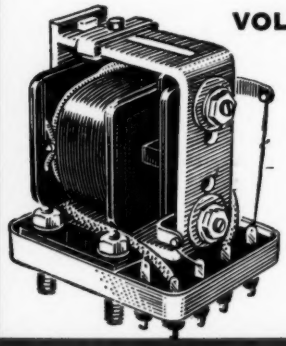
PANEL SEAL CO-AXIAL TYPE CX

Meets Spec. DEF 5000 for materials and finish.
Single pole changeover, rated at 30W RF in 50 ohms.
0.05 dB max. loss up to 400 Mc/s.
Crosstalk better than 40 dB down.



MINIATURE CO-AXIAL TYPE CY

Single pole changeover, rated at 1W RF in 50 ohms.
0.05 dB max. loss up to appx. 100 Mc/s.
−55°C to +100°C operational temperature range.
Better than 100 megohms insulation resistance at 250 V d.c.



VOLTAGE REGULATING TYPE XC 269

Fully Approved to S.R.D.E. Spec. 166/1.
Temperature compensated in range −40°C to +85°C.
Available for 6, 12 or 24 V operation.
Typical changeover voltage differential 1 V in 24 V.

meet the latest electronic requirements

Plessey

THE PLESSEY COMPANY LIMITED • (Relays and Control Systems Unit)
Eddes House • Eastern Avenue West • Romford • Essex • Tel: Seven Kings 6050
Overseas Sales Organisation: Plessey International Limited • Ilford • Essex • Tel: Ilford 3040

RSCI

Ergonomics in Equipment Design*

by B. SHACKEL, M.A., A.B.Ps.S.
Research & Engineering Psychologist, E.M.I. Electronics Ltd.

ERGONOMICS is the study of the relation between man and the environment in which he works, particularly the application of anatomical, physiological and psychological knowledge to the problems arising therefrom. In the design of equipment ergonomics, or human factors (the title used in the U.S.A.), places major emphasis upon efficiency, as measured by the speed and accuracy of human performance, in the use and operation of equipment allied with efficiency, are the safety and comfort of the operator. It is suggested that the most important question is not "Will the equipment work?" but "Will the average operator, easily and without error, be able to make it work as efficiently as its designer can? ".

In this paper a brief review is given of why and how ergonomic knowledge can help to improve the design of equipment. The relevant biological sciences and their kind of contribution are outlined. The field of work is described in terms of an analysis into three zones of interaction between the operator and his work, namely man-machine, man-workspace and man-environment zones. Examples of ergonomic research and its application to the design of specific machines are given in all three zones. The approach to system design is briefly mentioned and illustrations are made of the relevance of ergonomics to safety problems. References are given to the few textbooks available and to some of the useful research reports.

The practical aims of ergonomics are, therefore, the efficiency and safety of man-environment, and particularly of man-machine, combinations. These obviously are also aims of the design engineers, but ergonomics has a real contribution to make because of the now very considerable specialised knowledge available about human characteristics and performance. Textbooks or handbooks have been written for instance by Hick and Bates[9], Chapanis *et al.* [5], Woodson[20], and McCormick[14].

Relevant Biological Sciences

The biological sciences, from which specialised knowledge is applied, are functional anatomy, anthropometry, work physiology and applied or experimental psychology.

Functional anatomy is concerned with the body framework and the use of the muscles; it can, therefore, provide knowledge of the best ways in which force can be applied or objects lifted and also about the limits of joint movement. This knowledge is, of course, very important in the design of controls such as levers and foot pedals.

Anthropometry can give the designer data on body sizes and dimensions, for both male and female; it is very important but often forgotten that, when designing equipment for females, female dimensions should be used. For example, the usual height of a chair is eighteen inches, which appears to be too high for about 60% of the male population and about 80% of the female population.

Work physiology covers the whole field of bodily activity, and can now make reasonable measurements of physical work in terms of calory consumption. On the practical side, from this knowledge, it is possible to calculate the most efficient organisation of work and rest pauses to minimise fatigue, etc. (For example, Lehmann[12], Bonjer[1].)

Psychology can give information on how the operator receives, processes and acts upon information. From this knowledge one can define the requirements for displays, and also one can estimate the rate at which the operator can be given information by a system and can act upon it. For instance, it is not generally realised that an operator cannot receive two pieces of information simultaneously, and that if one piece of information is already " in the channel ", the receipt of a second piece may be delayed or inhibited[2].

The biological scientists from the above fields who are interested in ergonomics collaborate on an international as well as on an inter-disciplinary basis. This is largely because the Ergonomic Research Society, although founded in Great Britain, has quite a large international membership. The purpose which inspires this growing collaboration is a shared interest in the problems of man at work and a desire to join with engineers in creating better conditions and more efficient systems.

The Approach of Ergonomics

To fulfil the general aim, then, to produce well integrated man-machine combinations, the ergonomic approach jointly with the design engineers has three definite sections, some or all of which are implemented

*This paper is a contribution to the 1961 IMEKO Conference, Budapest, and is published this month simultaneously at the Conference, in the SIMA Review, and here by permission of the Scientific Instrument Manufacturers' Association.

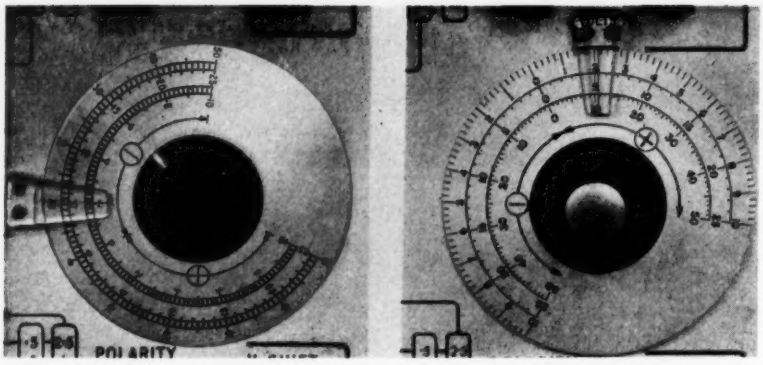


Fig. 1. Bad design (on left) of oscilloscope "Volts" dial scale greatly improved by redesign using ergonomic data (on right, E.MI. W.M16)

according to the type and complexity of system or apparatus being considered.

The first process, more significant with major systems than with individual instruments, is to examine the proposed system and decide which sub-tasks within the whole should be assigned to human elements and which to machine elements. Such factors as cost, weight, size, reliability, safety and efficiency, when considering in turn the use of man or machine for a sub-unit, must be assessed and compared for each sub-task separately, and then an optimum balance must be decided for the combination of sub-units to complete the system.

Secondly, for each instrument or for each part of a system where a human element is used, the interaction between the man and the equipment must be optimised. To do this, an approach is used which is slightly different from that of the engineer, who rightly must start his thinking from the machine and concentrate upon that. The ergonomic approach is to examine the task and the operational sequence which the man will have to do and then to work outwards from him, thus coming to examine his interaction firstly with the machine, and next with the immediate workspace around him (the chairs, desks, machine console, etc.), and finally with the general environment in which he and the machine are to work (thus coming to such problems as heating, lighting, ventilation, and the social structure of the group, team or factory of men in which he is). To ensure reasonable certainty of an adequate design it is important to consider these three zones of working out from the man—1. The machine, 2. The immediate workspace, and 3. The general environment—even though sure information is not always available, and even with smaller machines one can seldom know or allow for the many different types of general environment in which they may eventually be used.

Thirdly, the proposed and agreed final design should be evaluated by mock-ups and trials to test the validity of design decisions on human factor aspects, in exactly the same way that models and trials are used to check important engineering sections of any system. Such evaluation trials should particularly use samples of the expected final operators. The number of references to instruction books and the number and types of mistakes made by the trial operators are helpful scores from which to assess how simple a machine is to use and what parts should be improved.

If the above three processes are followed through wherever appropriate in the design and development stages, they will help to counteract the tendency to piecemeal design, which is the commonest cause of imperfections. The almost inevitable division, either of one design amongst several designers or of one designer's time amongst several small designs, may well lead to insufficient time or inadequate attention being given to the study of the complete working situation, of which each man and each machine forms a part.

In outlining below some examples of the application of ergonomics knowledge to the design of equipment, the field of work will be described in terms of the three zones of interaction between the operator and his work, as explained above, namely the man-machine, man-workspace and man-environment zones.

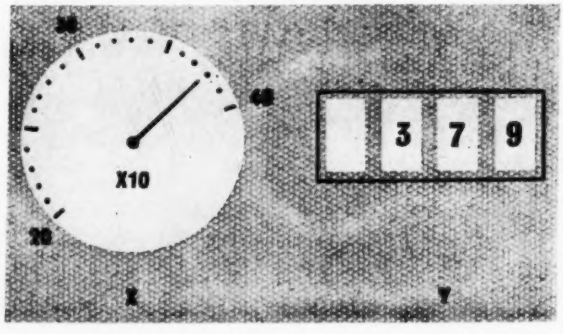
Man-Machine Interaction

This zone comprises the tools, instruments, material, and parts of machines which are immediately and necessarily "in contact" with the man as he does his work. In considering man-machine interaction it is useful to separate the three types of man-machine interface, which are displays, controls and panel layouts.

Displays

Displays should transduce information from machine to man quickly and efficiently. One of the commonest

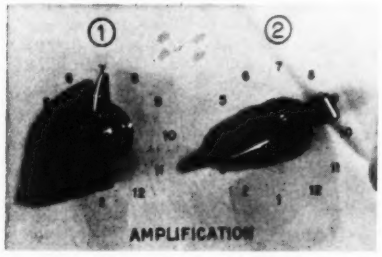
Fig. 2. The dial X gives the operator a sum to calculate, whereas the counter Y gives the answer



forms of display is the dial, but even simple dials can be misleading. The correct design of dial size, scale, lettering, etc., can be specified immediately from the textbooks [5, 13, 14, 20] for almost all applications. There is now no reason why operators should ever have to interpret dials such as that on the left of Fig. 1, when the clear re-design on the right can be deduced from the textbooks.

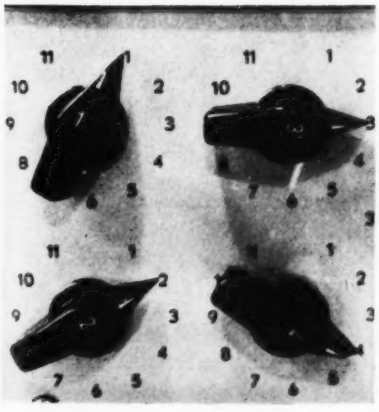
Many details affect the speed and accuracy with which man receives the information transmitted by a display. Particularly important is the contrast (whether the signal stands out clearly against its background), and the mode (whether the method of transmission is well suited to the type of information to be transmitted). On the question of mode consider Fig. 2; the dial, X, sets the man a piece of mental arithmetic, whereas the counter, Y, gives the answer immediately. When only numerical information is to be transmitted, a digital display is clearly much better; a good example of this principle in practice is the machine tool indicator designed by Gibbs[8]. However, dials are useful dual-purpose displays for giving exact readings occasionally but " snapshot " readings often, by the approximate angular position of the pointer. This, of course, is exactly the way in which we use our watches.

The watch face provides a simple illustration to lead from displays to controls. To operate most controls satisfactorily the man must first see or feel their present setting so as to decide which way and how far to move them. The control itself must, therefore, transmit some information to the man and must be designed suitably. Many selector switches move thirty degrees between each position, but are designed as in Fig. 3(a) so that the man must read the number each time. However, if the design in Fig. 3(b) is used, the very well learned ability to read a watch face at a glance enables the man to see and feel where the knob is pointing without reading the numbers at all.

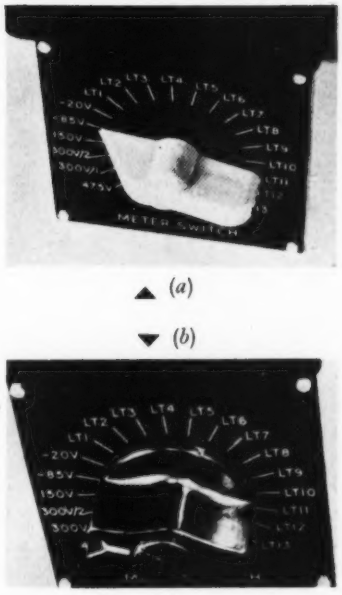


(a) The numbers must be read for every position

Fig. 3. Selector switches on two electro-encephalographs



(b) The operator can interpret at a glance the positions on the clock face layout



▲ *(a)*

▼ *(b)*

Fig. 4. Meter selector switch with (a) good and (b) bad control knobs, both of which are in fact pointing to the same position

Controls

Controls should transduce information from man to machine quickly and efficiently. The design of controls and knobs in size, shape and contrast is often imperfect. In Figs. 4(a) and (b) the same meter switch is seen from the operator's eye level with two different knobs.

The importance of good design in controls and their layout can be illustrated by an experiment required during the re-design of an analogue computer. This particular computer is a moderately sized, general purpose machine, of which the amplifiers, function potentiometers, etc., can all be interconnected in the usual way by the removable patch panel. For the operator, the essence of using this computer is the same as with most similar analogue computers, in that accuracy in setting-up and operating is more important than speed. Indeed, this requirement becomes more and more important for the operator with the growth of machines whose inherent speed relieves the operator of any serious speed stress, but instead requires that no errors should be made.

On the prototype machine the panel of function potentiometers (Fig. 5(a)) was somewhat confusing. It was easy to put the connecting jack into the wrong socket and adjust the wrong knob, or leave the right knob at the wrong setting, or even displace a knob by mistake when plugging or unplugging the jack. It was not possible to decide the best layout of these twenty-four connecting switches and potentiometer knobs from the published literature of ergonomics. An

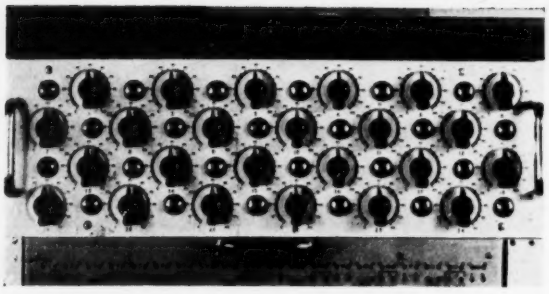


Fig. 5(*a*) *Prototype potentiometer panel for analogue computer with confusing layout of knobs and jack-sockets*

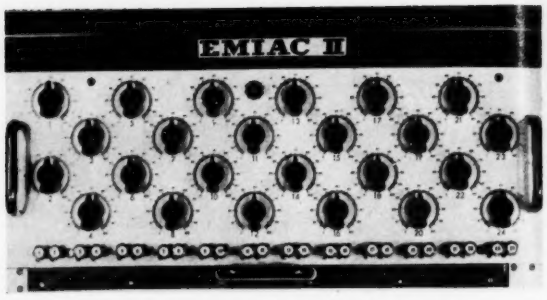


Fig. 5(*b*) *Redesigned panel, with clearer layout and separated switches, proved by experiment greatly to reduce errors*

experiment was therefore made to compare different layouts, and the final layout (Fig. 5(b)) was found to give faster performance and, above all, ten times less errors than the original layout (Shackel[17]). Since some of the setting errors on this panel, on the prototype machine, had taken a day or two to find (an experience which no doubt will have been familiar to any reader who has used analogue computers) this decrease in the number of errors is clearly of great importance.

The direction of movement of controls, with respect to the movement of the thing being controlled, is another important factor in ensuring no misunderstanding between man and machine. Evidence is now available (Fig. 6) in the textbooks for many types of control and display showing the relationships which men expect.

Panel Layout

Good layout of controls, as well as of panels generally, is important, otherwise the wrong control may be operated. Clearly the panel layout should guide the man through the sequence of operation by having a pattern which leads him correctly onwards, or, if there is no definite sequence of operation, at least it should show the various areas of associated components by patterns and groupings. Consider the layout of controls in Fig. 7; if asked to set a five-digit number with the knobs, most operators would immediately set the first three digits on the top row and the last two on the bottom pair of knobs. Closer inspection, however, shows that the correct sequence is in the shape of a letter W. Frequent errors were predicted and did occur before this panel was re-designed.

The importance of clear layout, and the value of applying principles resulting from psychological experiments on vision and perception, is again evident on another panel of the control console of the Emidec 2,400 computer. A linking panel is provided on which is indicated, by light signals, the state of connection and operation of all the tape units, and on which, by push buttons, the operator can make connections between the various relevant sections of the computer. Ease and accuracy of making these connections, and the avoidance of error, is obviously of some importance. The layout of this panel on the first prototype (Fig. 8(a)) is somewhat confusing. The application of principles derived from experiments by the Gestalt psychologists on the aspects of spatial layout, colour coding, etc., make more of the same push buttons easier to select without error on the final model (Fig. 8(b)).

To design a satisfactory panel layout, one preliminary process is essential; it is usually omitted. Before the design is finalised, the complete operating sequence must be analysed and preferably written out in minute detail; no substitute is adequate. In Fig. 9(a) is

Fig. 6. *Expected movement relationships between controls and displays*

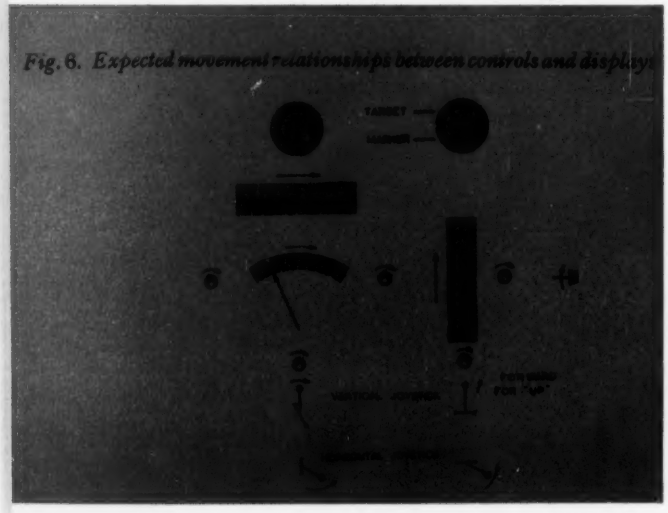
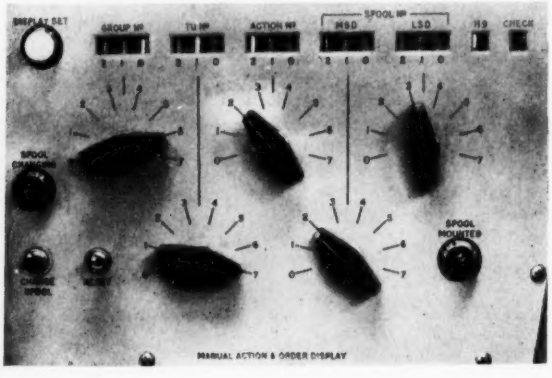
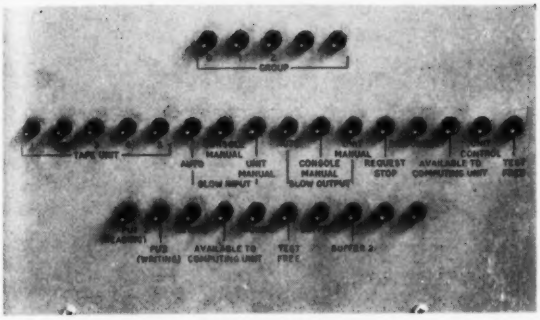


Fig. 7. *Bad layout of controls for sequential setting* (*see text*)





(*a*) *Prototype push-button layout*

(*b*) *Redesigned layout*

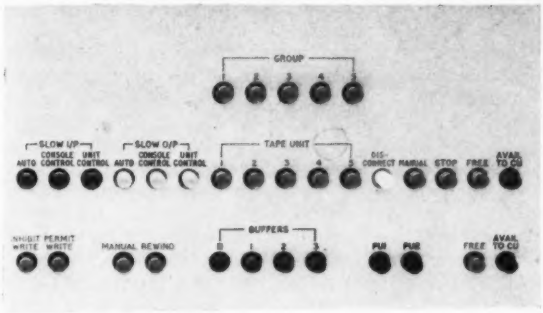


Fig. 8. *Linking panel on Emidec* 2,400

shown a panel layout, with the sequence of operation indicated by serial numbers and lines, as built on a prototype. After the sequence was analysed, a simple redesign resulted in the layout of Fig. 9(b).

Man-Workspace Interaction

The workspace zone comprises the larger spatial aspects of the machine, and the position and shape of relevant nearby furniture and machines, which influence in some way the position, posture and reach of the operator and the range of movement required and freedom of movement available to him. It often happens that machines, control consoles and similar large items are sketched and later drawn to half or quarter scale; when judged on the drawing-board, such designs may appear quite satisfactory because the true size is not easily visualised, and it is only when the machine is built that the bending and stretching it demands from the operator become obvious.

To solve such problems, two main techniques are needed. Firstly a full drawing-board analysis using anthropometric data is essential (e.g. Cathcart[4]; McFarland[15]; Dreyfuss[6]); secondly it is essential to build full scale mock-ups to validate the analysis (e.g. Morant[16]; Siegel and Brown[19]; Jones[11]), because different tasks require different movements, yielding postures with dimensions not predictable from the anthropometric data. An excellent example of a proper anthropometric survey and design study has been made in Great Britain by Floyd and Roberts[7], which has

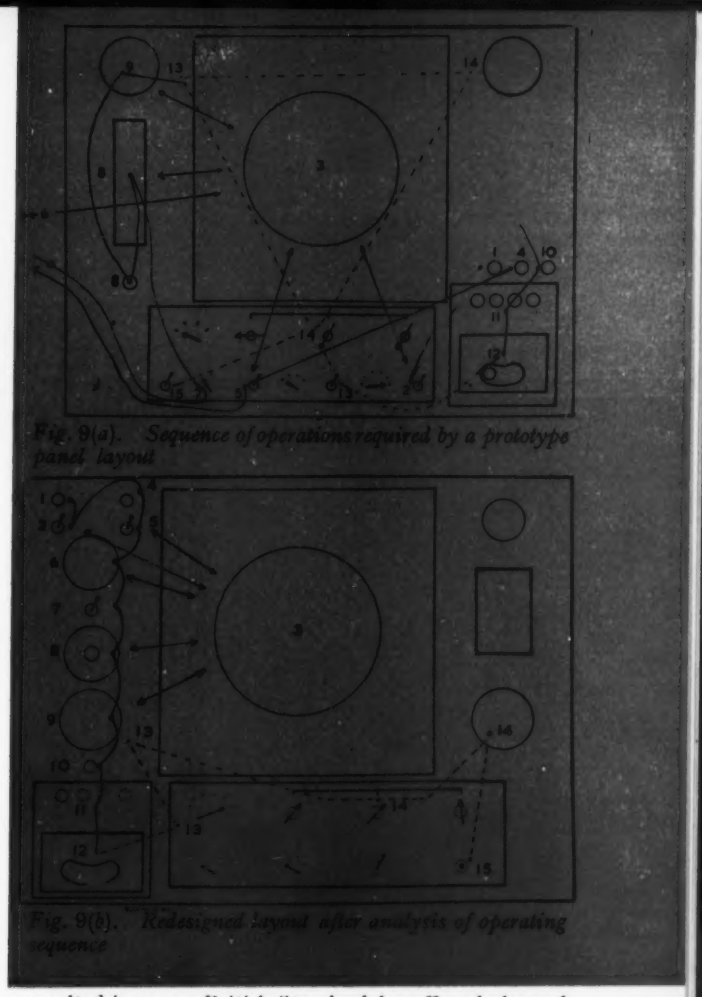


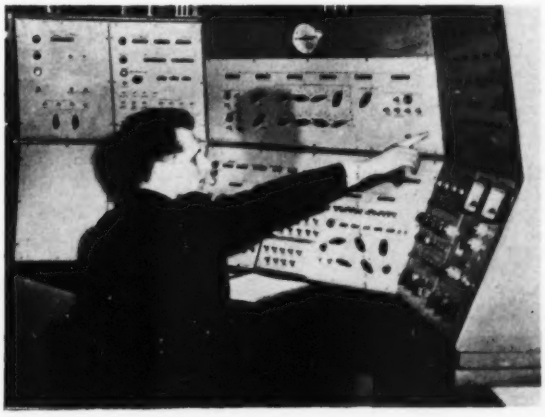
Fig. 9(*a*). *Sequence of operations required by a prototype panel layout*

Fig. 9(*b*). *Redesigned layout after analysis of operating sequence*

resulted in a new British Standard for office desks and chairs; as a result of the scientific research involved, we can be certain that between 75% and 80% of the population will be properly fitted by furniture built to the new standard.

The Emidec 2,400 computer again provides a useful

Fig. 10. *Control consoles should be tailored to fit the operator; shapes and sizes which look correct may not actually be correct*



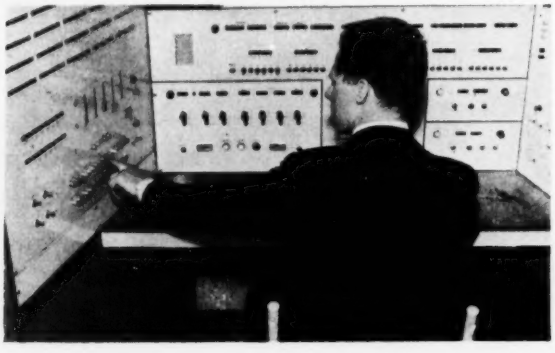
▲ (*a*)

Fig. 11. *Mock-ups show that the side limb of the console at* 30° *beyond a right angle would be too far away and at* 0° *would be too near the operator*

▼ (*b*)

practical example. The first prototype was built experimentally, without ergonomic analysis, and the workspace aspect for a typical operator can be seen in Fig. 10. Using anthropometric data, a drawing-board analysis including the new engineering requirement for for vertical panels resulted in a decision for a main central section 42 inches wide, with an angle between this section and the side limbs of 15° beyond a right angle. A very simple adjustable mock-up was built to validate the decisions and showed clearly that 30° beyond the right angle is too far, Fig. 11(a), 0° is too cramping, Fig. 11(b), and that the decision in favour of 15° was exactly right (Fig. 12).

Fig. 12. *The final console of the Emidec* 2,400 *computer, devised from drawing-board analysis with anthropometric data and validated by mock-up trials*



Man-Environment Interaction

The environmental zone comprises the physical, chemical and psychological aspects of the general surroundings, any or all of which may physiologically and psychologically influence the man at his work, or may affect the machines or the workspace and through them indirectly influence the man. This zone obviously covers a very wide field, including problems of lighting, noise, heat, ventilation, gravity, movement, chemical composition, etc., and psychological aspects of the working team, the methods of work supervision, the timing and duration of work periods, and the general social setting within which the man, his workmates, his supervisors and the whole factory is placed.

In the time available, it is only possible to mention as an example one part of one of these many aspects, lighting. It is surprising how often this particular environmental factor interferes with other aspects of a man-machine working situation[10]. Consider, for instance, this electrical control room (Fig. 13) where half the effort in designing the clearly laid-out panels has been wasted because the operator at his desk views them with extremely bright windows immediately behind and above them. Examining the room as one whole working unit during the design stage, instead of as a room needing large windows (the specification to the architect) and as a series of panel units with a desk (the problem before the design engineers), would surely have prevented the severe disability glare caused by these windows. Similarly, the instrument shown in

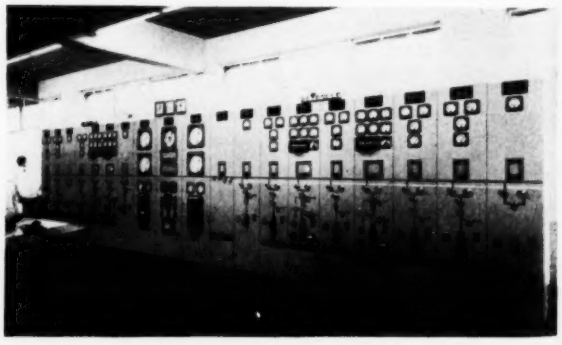


Fig. 13. *Electrical control room with clear panel layout but excessive glare from windows*

Fig. 14 is generally satisfactory, but it was found under difficult lighting conditions which resulted in specular reflections seriously obscuring the display.

When designing major systems, it should always be the aim not merely to learn of details of the expected environment, but also, if possible, to collaborate with architects, industrial designers and works engineers to ensure that the details of this zone also are co-ordinated with the man-machine equipment design. Despite the difficulties that this sometimes involves, it is pleasing to be able to report that in at least one of the large

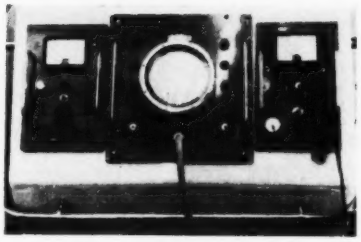


Fig. 14.
Specular reflections from bad lighting obscure the display of an operating theatre instrument

Emidec 2,400 computer installations we have been able to work in close collaboration with the architects; it has thus been possible to ensure that the position and type of lights built into the ceiling of the computer hall will not cause specular reflections from any part of the console desk into the eyes of the operator.

Ergonomics and Safety

The chief aim and result of applying ergonomics knowledge to the design of equipment is to improve the efficiency and comfort of the man at work with the machine. In improving the efficiency, it is usually the aim, depending upon the system concerned, either to improve speed while accepting errors at a certain level or to decrease errors to below a certain rate while accepting the speed which results. However, there are other situations in which it is essential to avoid, if possible, any chance whatsoever of human error. Here again ergonomics can assist considerably (Shackel[18]).

A field in which this safety aspect is particularly important is that of medical electronics, where the safety of the patient is even more important than safety for the operator. A very simple but significant observation from ergonomics is that men inevitably make mistakes sometimes, and therefore that machines should be designed in such a way that they, as it were, monitor the man and prevent serious danger arising from his mistakes, or better still prevent him making a mistake. This aim is neatly achieved on a new cardiac stimulator which has two voltage ranges, and when set anywhere on the low range cannot, because of an interlock (Fig. 15(a)), be changed to give an output voltage in the high range without first being reset to zero output. Moreover the scale on the setting dial has shutters exposing the appropriate range numbers only (Fig. 15(b)), which greatly simplifies reading.

It may perhaps be interesting to mention, as a concluding example, an instrument design in hand at present. This instrument is a contamination monitor (Brown[3]) for use in nuclear electricity-generating stations and similar places where particularly maintenance personnel, as a matter of routine at the end of each day, must wash and then check their hands for any possibility of contamination. The chance of contamination is not high, and therefore the use of this instrument, into which the operator places both his hands for automatic checking, will quickly become a matter of ordinary routine. When such procedures become a habit, little conscious attention is given to them, and the apparatus must, therefore, be truly foolproof. Apart from placing his hands, perhaps rather carelessly, into the appropriate holes, the man should not have to do anything else at all, otherwise there will be occasions when he will not do that extra something (which may be reading a lamp or putting his hands into a proper position in the hole, etc.). Once the minimum starting action has happened the machine must not allow the man to leave until the proper test, passing him as safe, has occurred. All other eventualities should cause the machine to call him back for a proper test. The essential analysis of all possible man-machine actions and interactions, and the design of the instrument functions and sequence so that the man, despite himself, is compelled to be safe, has been an interesting and fruitful exercise.

Conclusions

From general experience of present instruments and apparatus it seems not unreasonable to conclude that, for ease of use and efficiency in the hands of the actual operator, the designs do not in general match the high level of technical performance achieved. There is a real need for greater dissemination of knowledge about the characteristics of man as a machine operator. Ergonomics, or human factors, is the name for the

Fig. 15(*a*). *Cardiac stimulator with interlock preventing change of output range*

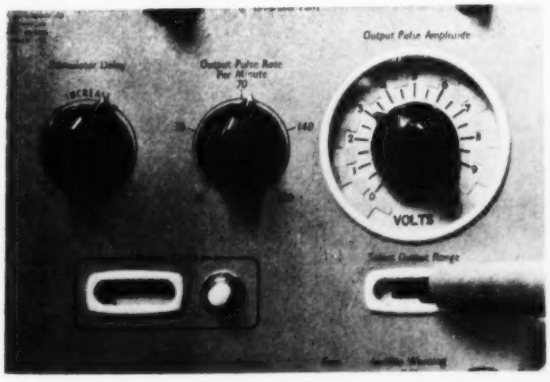
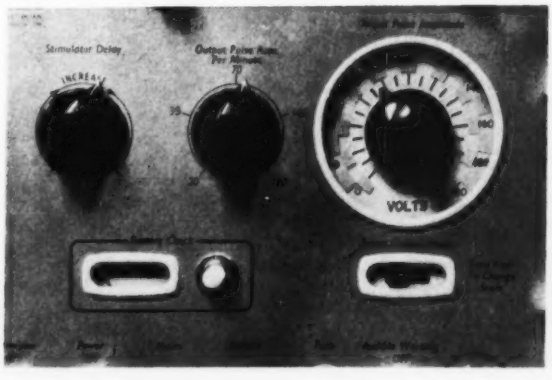


Fig. 15(*b*). *After range changed with knob at zero, correct new scale numbers only are visible*



scientific study of this field and the application of knowledge about it to the design of equipment.

Acknowledgements

The permission of the Controller, H.M.S.O., the Editor of *Design*, and the Institution of Electrical Engineers, to publish certain of the illustrations is acknowledged. The Directors of E.M.I. Electronics Ltd., are thanked for their support and permission to publish the results of this work.

References

1. F. H. Bonjer. The effects of aptitude, fitness, physical working capacity, skill and motivation on the amount and quantity of work. *Ergonomics*, **2**, 1959, pp. 254-261.
2. D. E. Broadbent. Perception and Communication. 1958, London: Pergamon.
3. J. R. Brown. Simultaneous hand and clothing checking for alpha and beta contamination. Proc. 2nd Internat. Confer. U.N. Peaceful Uses of Atomic Energy, **23**, 1958, pp. 408-413.
4. E. P. Cathcart, D. E. R. Hughes and J. G. Chalmers. The physique of men in industry. I.H.R.B. Rept. 71, 1935, London: H.M.S.O.
5. A. Chapanis, W. R. Garner and C. T. Morgan. Applied Experimental Psychology. 1949. New York: John Wiley and Sons.
6. H. Dreyfuss. Tailoring the product to fit. *Industrial Design*, **7** (6), June, 1960, pp. 68-81.
7. W. F. Floyd, and D. F. Roberts. Anatomical and physiological principles in chair and table design. *Ergonomics*, **2**, 1958, pp. 1-16.
8. C. B. Gibbs. A new indicator of machine tool travel. *Occupat. Psychol.*, **26**, 1952, pp. 234-242.
9. W. E. Hick and J. A. V. Bates. The human operator of control systems. 1950. Ministry of Supply Monograph 17/204.
10. R. G. Hopkinson and J. Longmore. Attention and distraction in the lighting of work-places. *Ergonomics*, **2**, 1959, pp. 321-334.
11. J. C. Jones. Fitting for action. *Design*, No. 137, May, 1960, pp. 49-52.
12. G. Lehmann. Physiological measurements as a basis of work organisation in industry. *Ergonomics*, **1**, 1958, pp. 328-344.
13. A. J. Maddock. Design of scales for industrial instruments. *Brit. J. Appl. Phys.*, **12**, 1961, pp. 33-43.
14. E. J. McCormick. Human Engineering. 1957. New York: McGraw Hill.
15. R. A. McFarland. Human body size and capabilities in the design and operation of vehicular equipment. 1953. Boston: Harvard School of Public Health.
16. G. M. Morant. Human Factors in Equipment Design, (Body size and work spaces). 1954. Edit, W. F. Floyd and A. T. Welford. London: H. K. Lewis.
17. B. Shackel. Note on panel layout for numbers of identical items. *Ergonomics*, **2**, 1959, pp. 247-253.
18. B. Shackel. Machine design for safety. 1959. Proc. Nat. Industr. Safety Conf., RoSPA.
19. A. I. Siegel and J. R. Brown. An experimental study of control console design. *Ergonomics*, **1**, 1958, pp.251-252.
20. W. E. Woodson. Human Engineering Guide for Equipment Designers. 1954. Berkeley: Univ. of California Press.

Honeywell Electronic Data Processing Division

Honeywell Controls Ltd. is setting up an Electronic Data Processing Division in London to market two computers in this country. The two computers to be introduced are the Honeywell 400 and the Honeywell 800. The company's production facilities in Boston, U.S.A. have been expanded and a computer can now be delivered within fifteen months, and in some cases twelve.

Honeywell 800

This medium-to-large system will perform up to eight independent computing operations concurrently. For example, it will answer a random enquiry, bring an inventory up to date, process a payroll, perform a complex engineering calculation, make a special analysis, and handle other jobs. Other features are orthotronic control (the ability to detect and correct errors without human intervention) and Honeywell's extensive library of automatic programmes. The computer is of a modular design and average speed is 40,000 three-address operations per second; 1·67 million numbers or letters.

The Honeywell " 800 " data processing computer known as FACT (Fully Automatic Compiling Technique) eliminates manual programme coding by enabling the computer itself to translate business English into machine language. The use of FACT makes it possible to write and check out programmes five to ten times faster than by previous manual techniques.

Cash price for the average system: £395,000. Monthly rental: £8,500.

Honeywell 400

The Honeywell 400 is the junior version of the Honeywell 800. It is a full-scale magnetic tape data processing system for small organisations. The " 400 " and " 800 " use the same tape units and other auxiliary equipment. Any programme prepared for the " 400 " can be run on the " 800 ". This compatibility of the two computers means that it is easy for a growing company to change from " 400 " to " 800 " as soon as its processing needs warrant the larger system. Also the compatibility is useful for decentralised companies: programmes run on local "400's" can be easily integrated with programmes run on the head office "800".

The " 400 " can handle an average of 10,000 three-address operations per second. Monthly rental: £3,090. Cash price: £139,000. This includes the central processor, an independent console, four high-speed magnetic tape units, a 900 line/min printer and a 650 cards/min card reader.

Services

A major aspect of Honeywell's Electronic Data Processing operations in Europe will be the establishment of E.D.P. centres in various locations. The first of these will be established in London and will provide for complete customer E.D.P. services, including:

1. Customer educational facilities
2. Customer operator and programme check-out work
3. Customer H-800 and H-400 " back-up " facilities
4. Customer service bureau facilities—performed by the Honeywell staff or by the customer's staff.

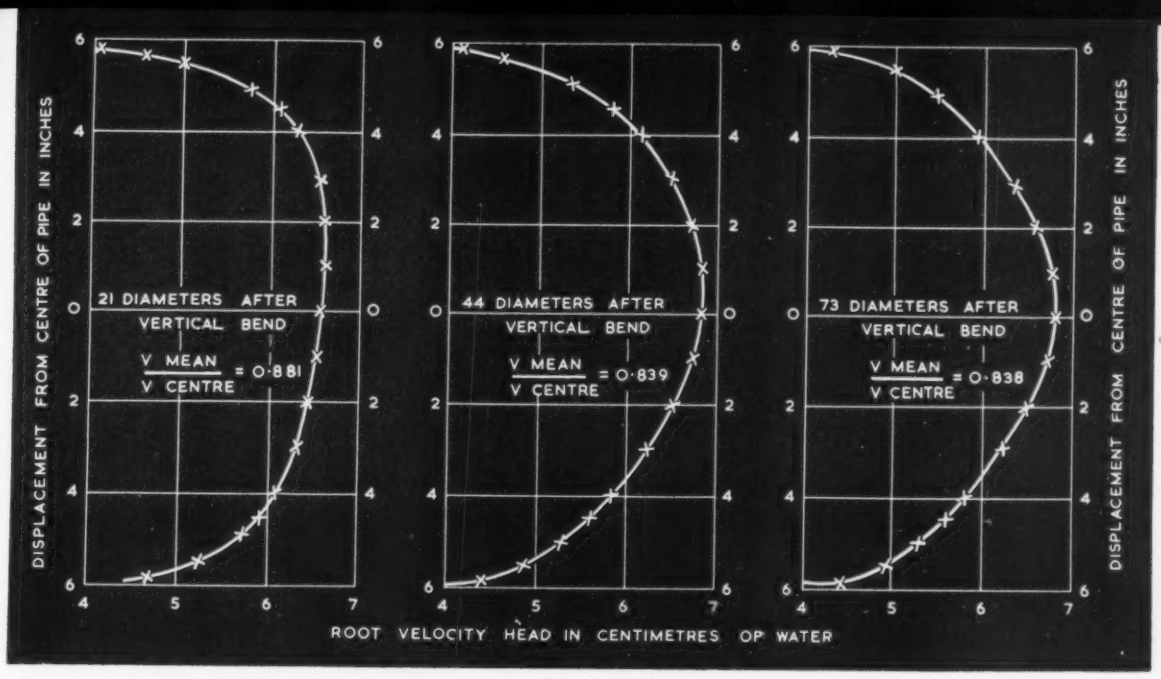
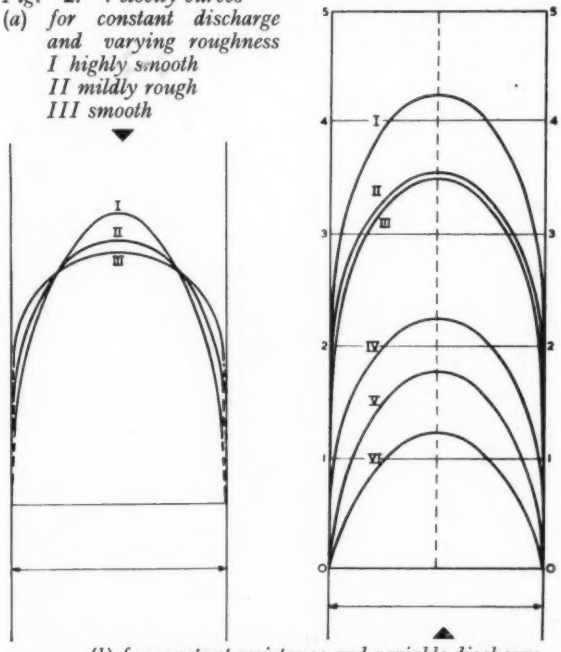

DISPLACEMENT FROM CENTRE OF PIPE IN INCHES
21 DIAMETERS AFTER VERTICAL BEND
V MEAN / V CENTRE = 0·881
44 DIAMETERS AFTER VERTICAL BEND
V MEAN / V CENTRE = 0·839
73 DIAMETERS AFTER VERTICAL BEND
V MEAN / V CENTRE = 0·838
DISPLACEMENT FROM CENTRE OF PIPE IN INCHES
ROOT VELOCITY HEAD IN CENTIMETRES OF WATER

Fig. 1. Velocity distribution variation with pipe length in a 12 in. pipe

Comparison of Coefficient Data for Rough and Smooth Pipes

By R. G. WEST
Head of the
Fluid Dynamics Laboratory
Electroflo Meters Co., Ltd.

Fig. 2. Velocity curves
(a) for constant discharge and varying roughness
I highly smooth
II mildly rough
III smooth



(b) for constant resistance and variable discharge
I smooth surface
II & III wavy surface
IV, V & VI increasing roughness
(Reproduced by permission of Princeton University Press)

THE previous articles discussed a programme of tests to be made on some primary elements and indicated in what manner they were to be made, together with some reasons for choice of test procedure. This article is concerned with the results of the investigation with particular reference to coefficient data.

After comment on the velocity profiles and associated data, the article is in two main parts. The first will be concerned with the discussion of test results made using a rough test line and the second with a smooth test line.

Velocity Profiles

These profiles, shown in Fig. 1, are included as an example of the modification to velocity distribution at constant Reynolds number which takes place in a long 12 in. test line. The first profile is flat, resulting in a high value of V_m/V_c and is due to a right angle bend just upstream of the point of traverse, in which guide vanes are fitted. Points to note are that a considerable distance is needed before the velocity profile is developed properly, but that once it is there is little further change to the shape.

This is not to be confused with the way in which the velocity distribution in a long pipe connected to a large tank or reservoir, may vary and develop with Reynolds number. Fig. 2 which is taken from "The

Note: Referring to " The Influence of Pipe Conditions on Flow Measurement " *Instrum. Pract.*, May, 1961, p. 557 the ratios $\frac{\text{V mean}}{\text{V centre}}$ in Fig. 1 should read
0·881 (21 diameters after vertical bend)
0·839 (44 diameters after vertical bend)
0·838 (73 diameters after vertical bend)
The amended diagram is shown on Fig. 1 above.

Mechanics of Turbulent Flow" [1] and is due to Fritsch, shows some of the velocity distribution profiles which may occur. Since these may vary with pipe length as well, it should be clear that dogmatism about the importance of profile shape alone is out of place.

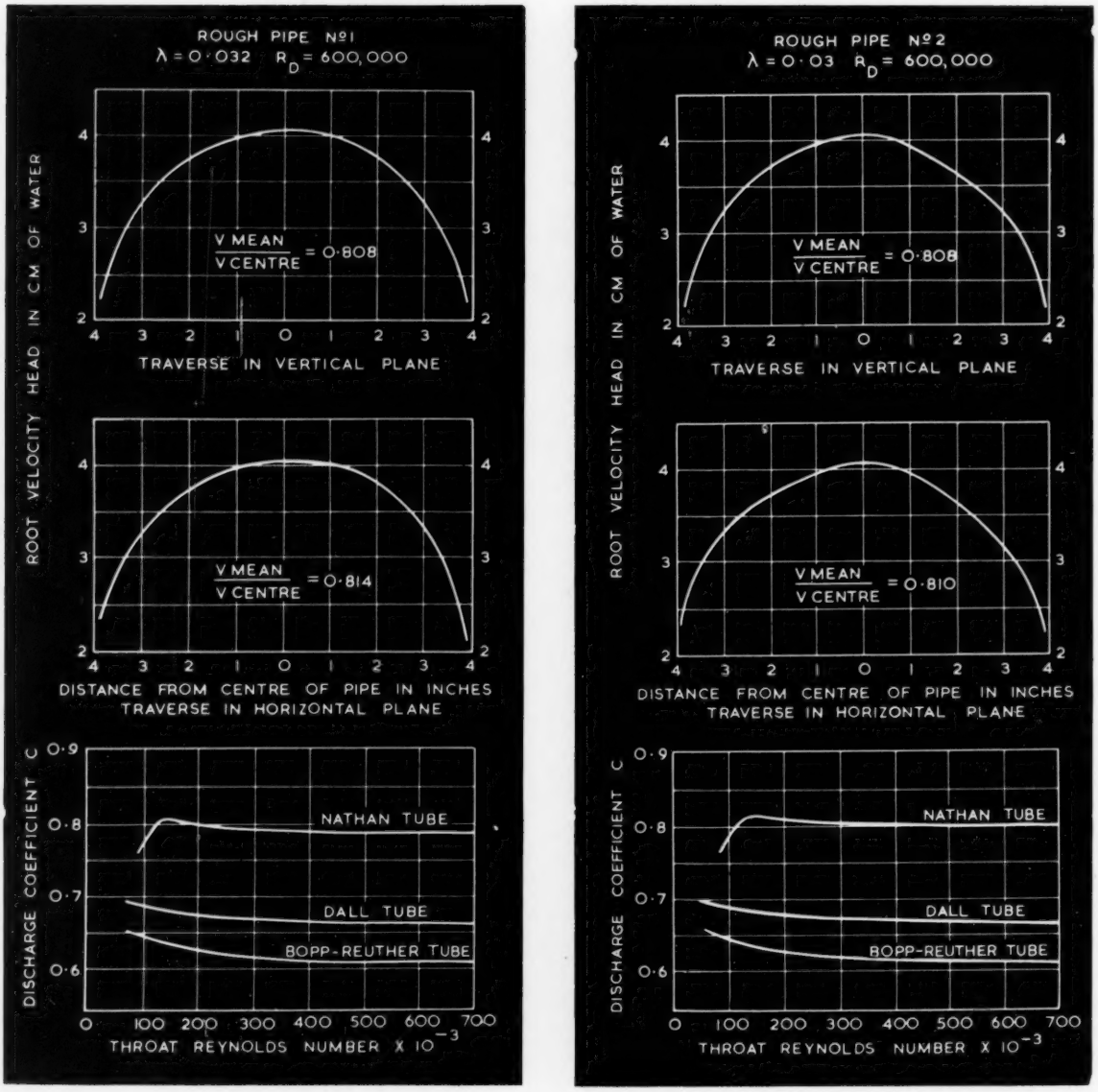
Instead, the circumstances under which the profile was obtained such as the length, pipe roughness, roughness pattern and diameter of pipe, together with friction coefficient data, V_m/V_c, Reynolds number are all inseparable items of correlation of velocity profile with test data is to have any value.

These remarks are borne out by the data given in Figs. 3 and 4 for rough and smooth test lines.

Although the roughness height is almost the same for both pipes there is, as has already been mentioned, a different roughness pattern covering a proportion of the internal wall area of one pipe. In spite of this, the variation in V_m/V_c is negligible, although it is true that the higher value of V_m/V_c is associated with the higher value of friction coefficient, and the shape of the velocity profiles are similar. There is some change in the friction coefficient which may reflect the roughness pattern, and possible variations in mean roughness height within that pattern.

The actual values of the friction coefficient $\lambda = 0{\cdot}030$ and $\lambda = 0{\cdot}032$ and the shape of the profiles are in good agreement with published data for a pipe for which $D/k = 160$[2].

Fig. 3. Test data for two 8 in. rough test pipes (actual bore = 8·00 in.)


ROUGH PIPE Nº1
λ = 0·032 R_D = 600,000
ROOT VELOCITY HEAD IN C.M. OF WATER
V MEAN / V CENTRE = 0·808
TRAVERSE IN VERTICAL PLANE
V MEAN / V CENTRE = 0·814
DISTANCE FROM CENTRE OF PIPE IN INCHES
TRAVERSE IN HORIZONTAL PLANE
DISCHARGE COEFFICIENT C
NATHAN TUBE
DALL TUBE
BOPP-REUTHER TUBE
THROAT REYNOLDS NUMBER X 10^-3
ROUGH PIPE Nº2
λ = 0·03 R_D = 600,000
V MEAN / V CENTRE = 0·808
V MEAN / V CENTRE = 0·810

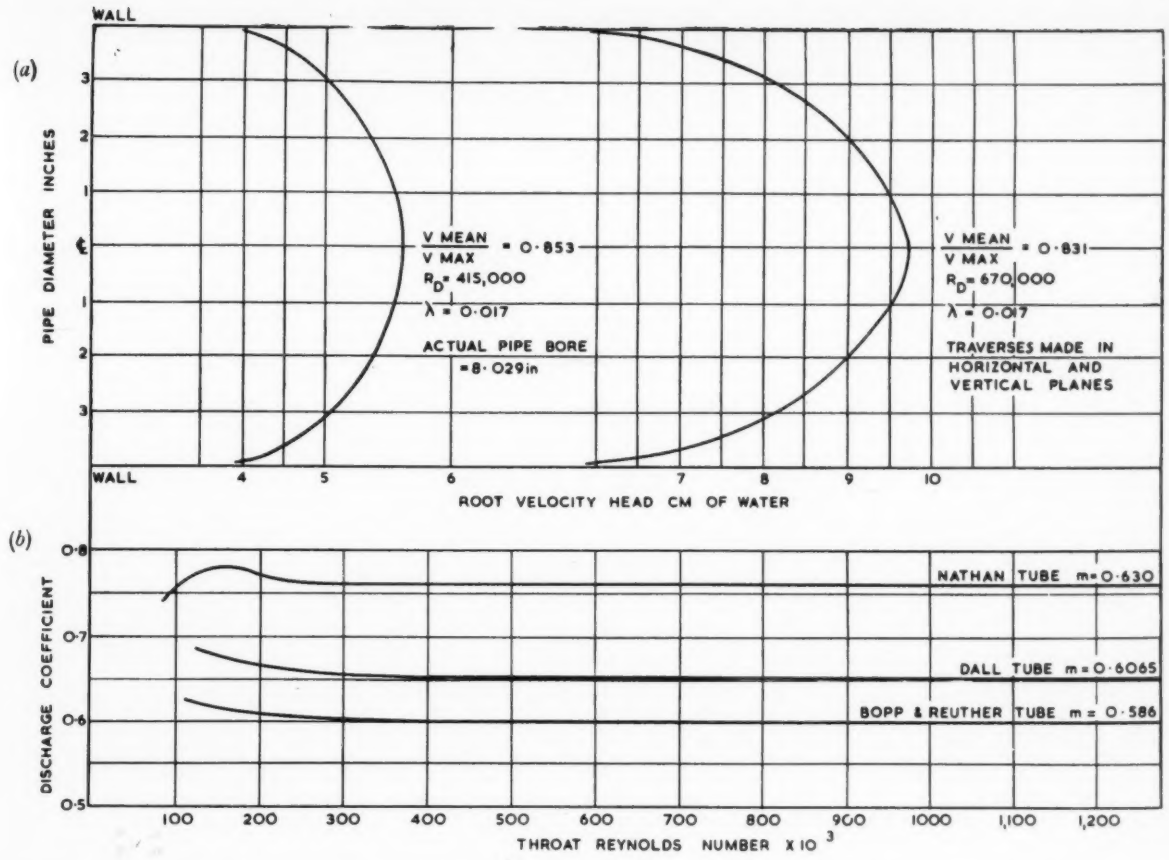

(a)
WALL
PIPE DIAMETER INCHES
V MEAN / V MAX = 0·853
R_D = 415,000
λ = 0·017
ACTUAL PIPE BORE
= 8·029 in
V MEAN / V MAX = 0·831
R_D = 670,000
λ = 0·017
TRAVERSES MADE IN HORIZONTAL AND VERTICAL PLANES
ROOT VELOCITY HEAD CM OF WATER
(b)
DISCHARGE COEFFICIENT
NATHAN TUBE m = 0·630
DALL TUBE m = 0·6065
BOPP & REUTHER TUBE m = 0·586
THROAT REYNOLDS NUMBER X 10 3

Fig. 4. Test data for 8 in. smooth test pipe in clean machined condition ($\lambda = 0{\cdot}017$, *actual bore* = 8·029 *in.*)
(*a*) *Velocity distribution*
(*b*) *Friction coefficient data*

The velocity profile and friction coefficient data are shown on Fig. 4. There is again reasonable agreement between these and the 12 in. pipe data shown on Fig. 1 as well as with Fig. 2 and with published data for a pipe with D/k = 2,600[2]. It should be noted that this pipe with a value of $\lambda = 0{\cdot}017$, which for the purpose of these tests is described as smooth by contrast with the rough pipe, would be considered in some papers as commercially smooth or mildly rough, etc.

Although it is of secondary interest, a velocity profile is also given for a lower Reynolds number and it is worth noting that the friction factor alone would not indicate the effect on coefficient data which this change of Reynolds number and profile shape would cause. This, in turn, means that D/k by itself which in some writing is not even associated with λ, is also of little value as a means of correlation.

Finally, Table 1 shows that equivalent pipe lengths have not avoided quite marked differences in the values of V_m/V_c obtained and it is clear that large values of this ratio cannot easily be obtained and most certainly were not available in the past.

TABLE 1
Summary of Pipeline Characteristics

Pipe Size and Condition	Friction Coefficient λ	V_m/V_c
8 in. smooth	$R_D < 500{,}000$ λ = 0·017	0·853
8 in. rough	$R_D > 500{,}000$ λ = 0·030	0·810
	λ = 0·032	0·814
8 in. smooth	λ = 0·017	0·831
12 in. smooth	λ = 0·017	0·838

Coefficient Tests with Rough Pipes

Nathan Tube

Coefficient of discharge data for an 8 in. Nathan tube are shown on Figs. 4 and 5. It is clear that this type of tube retains the hump in the coefficient curve

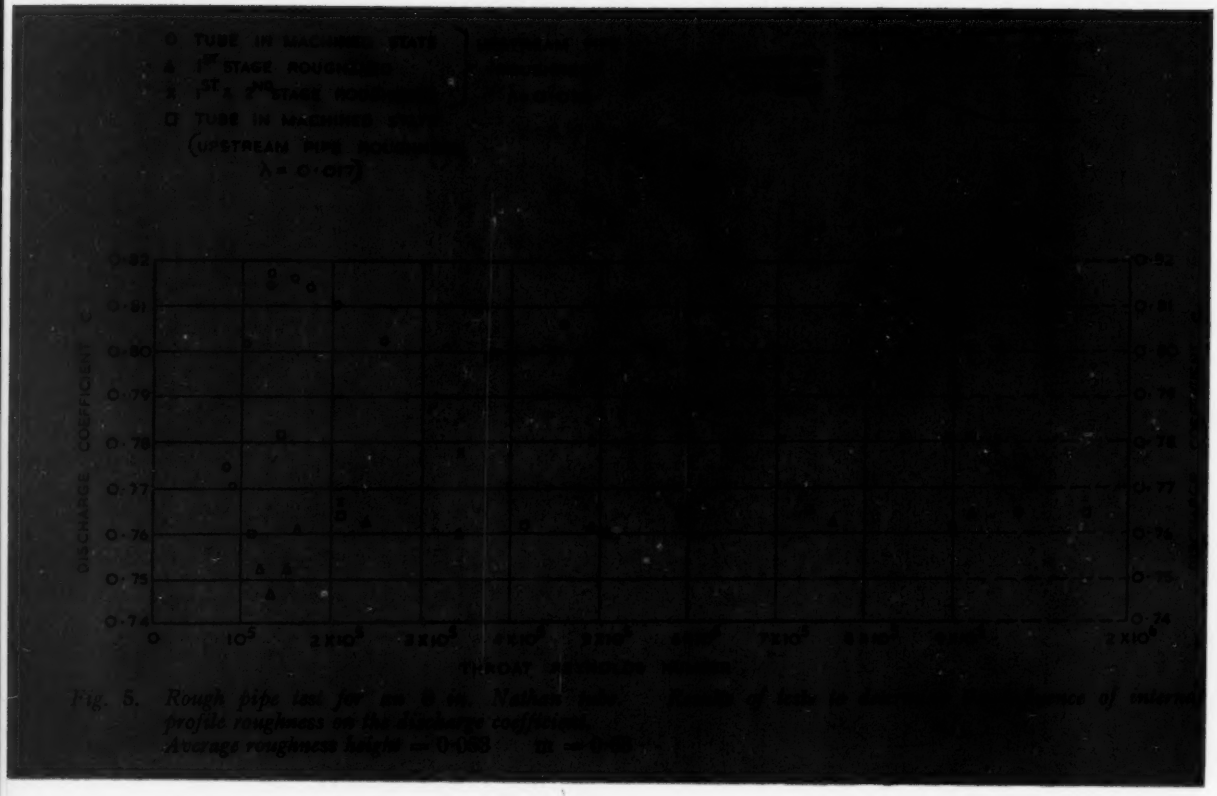


Fig. 5. Rough pipe test for an R.B. Nathan tube. Effects of [illegible] profile roughness on the discharge coefficient.
Average roughness height = 0·033 in = 0·83

noted, by Schlag [3] and Witte[4], more recently again by Schlag[5] and by Spencer and Thibessard[6], to be characteristic of classical Venturi tubes.

However, there are some points of difference: the Nathan tube coefficient increases in the range $100 < R_d < 200{,}000$ and the maximum deviation is 2% above the constancy value.

This is in contrast to the classical Venturi tube for which Witte[4] found that maximum deviations of less than 1% were likely, and that the position of maximum deviation varied with Reynolds number, area ratio and to some extent with pipe size. Some of his results are shown in Fig. 6; he ascribes the hump to the form of the profile at the point at which the inlet cone meets the parallel throat.

There is a marked similarity between these dotted curves and those of the Nathan tube, particularly the sharp fall which occurs after the hump.

The value of the coefficient obtained at or above constancy limit $C = 0{\cdot}80$ is midway between that of a standard Venturi and of a standard orifice, but the constancy limit is certainly greater than $R_d = 600{,}000$. There is some instability at $450 < R_d < 550{,}000$ as is shown by the scatter of test points, but above this the coefficient values are remarkably steady up to $R_d = 1{,}000{,}000$.

Dall Tube

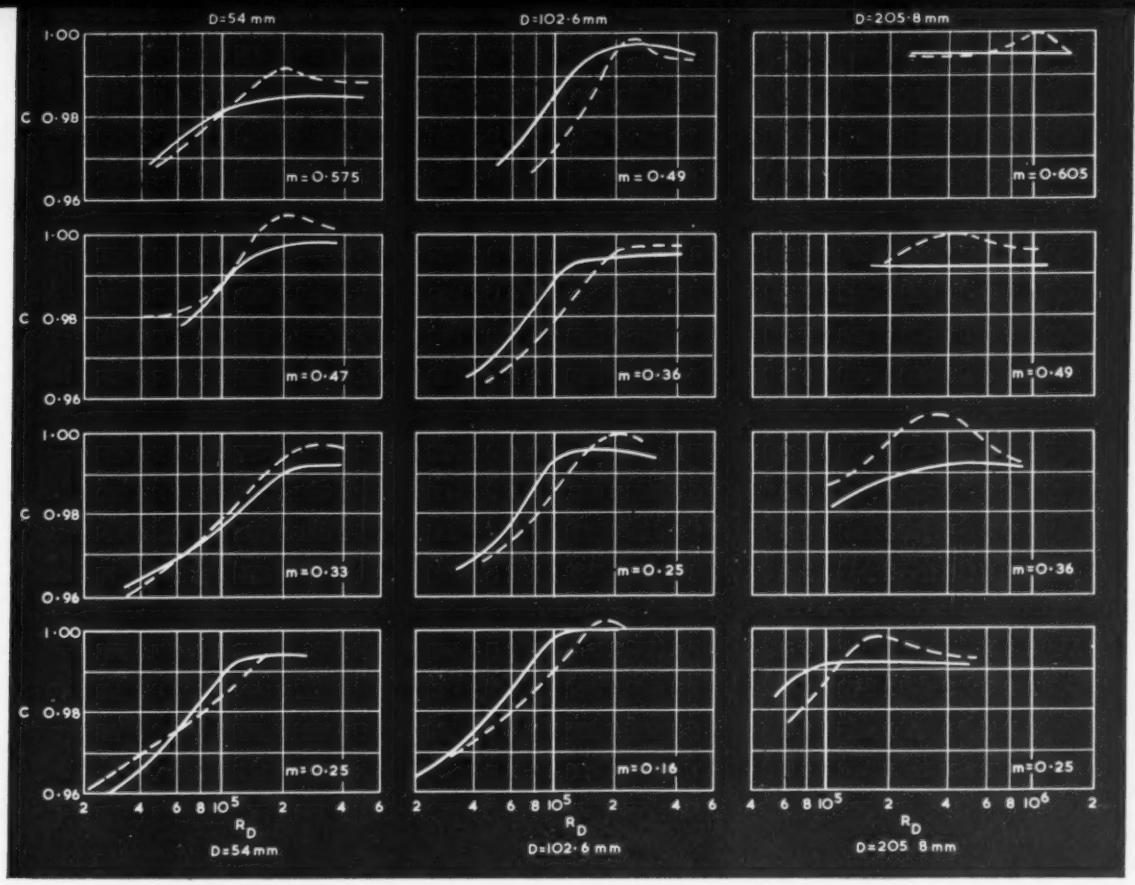
The coefficient of discharge data are shown on Figs. 3 and 7. In this case the characteristics are quite different from those of the classical Venturi tube. There is every indication that the constancy limit is not less than $R_d = 1{,}000{,}000$, and judging by the trend of the curve, the value of the coefficient at or above the constancy limit will be $C = 0{\cdot}660$ approximately.

These tests do not therefore support published information. In the paper by Miner[7], the constancy limit for a tube of equivalent area ratio is given as $R_d = 450{,}000$ and the coefficient value at or above this limit as $C = 0{\cdot}641$. The top curve Fig. 7(a) has been constructed from the values and trends shown in this paper. Furthermore, these tests show that in the range $100 < R_d < 1{,}000{,}000$, C has changed by about 4%. This is again in general contradiction to the information given by Miner about a Dall tube ($m = 0{\cdot}535$) which has a constancy limit $R_d = 477{,}000$ with a coefficient value at this limit $C_d = 0{\cdot}662$ which rises to $C = 0{\cdot}677$ at $R_d = 100{,}000$, a change of 2·3%. (Fig. 8).

The curves which Miner has published, show only a few test points, but it appears that the scatter of points is less than has been obtained in the present series of tests. There is some indication of instability at and around $R_d = 500{,}000$.

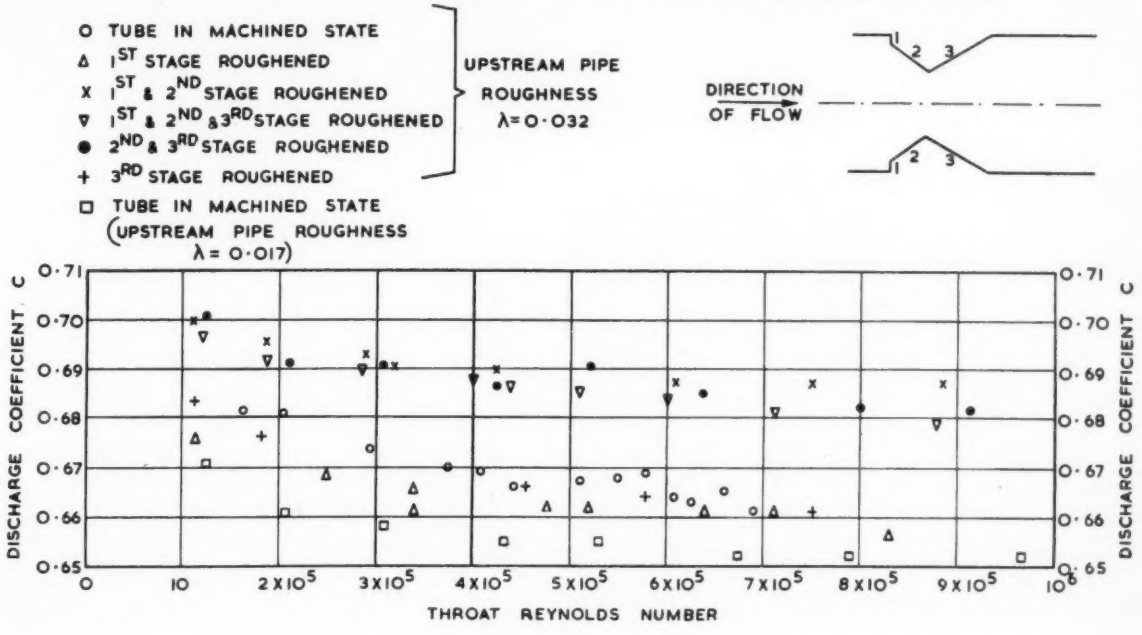
Bopp and Reuther Tube

Coefficient of discharge data are shown on Figs. 3 and 9. The characteristics of the curve are again quite different from those of classical Venturi tubes. There are some significant features to note: the slope of the curve is quite pronounced and the scatter of test points greater than would normally be expected.



▲ *Fig. 6. Flow coefficients of classical Venturi tubes* (*Reproduced by permission of Brennstoffwärmekraft*)

▼ *Fig. 7. Rough pipe tests for an 8 in. Dall-tube. Results of tests to determine the influence of internal profile roughness on the discharge coefficient. Average roughness height* = 0·053 *m* = 0·6065



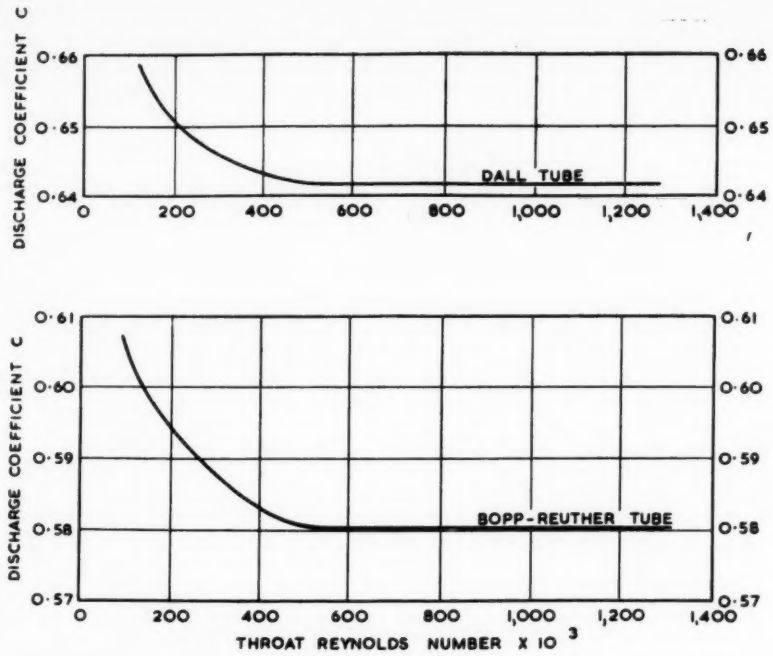
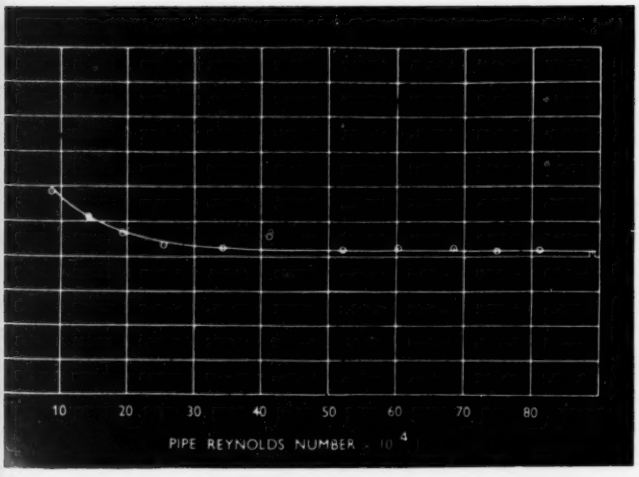


Fig. 7(a), 7(b). Published coefficient data of Dall and Bopp and Reuther tubes

Nevertheless, even allowing for the signs of instability at $R_d = 600{,}000$ there is an indication that the constancy limit will be in the region $600 < R_d < 800{,}000$.

In respect of scatter and constancy limit these tests show reasonable agreement with published information[8, 9], but the value of coefficient at or above the constancy limit C = 0·614 is at variance with the published value C = 0·580 (Fig. 7(b)) which rises to C = 0·605 at $R_d = 100{,}000$. The extent of this increase, approximately 5%, agrees very well with that given by the present tests.

Fig. 8. Calibration of an 8 in. Dall flow tube



Experimental Orifice Plate

Since one of the features of this design is that any chosen value of C can be obtained irrespective of pipe size by using a suitable diameter ring, it is only necessary to draw attention to the low constancy limit and to the reduced scatter of test points (Fig. 10). These same characteristics are apparent in the tests shown in Fig. 3 of the introductory article. (*Instrum. Pract.*, April, 1961, pp. 440-446.)

Comparison of Results

These results show that the Dall tube and the Bopp and Reuther tube have very similar characteristics. They are both subject to Reynolds number influence, but it is clear that the Bopp and Reuther tube is less dependent than the Dall tube on Reynolds number. Against this must be set the fact that the Dall tube appears more stable, although the instability of both devices at Reynolds numbers in the region of $R_d = 500{,}000$, suggests that these designs are subject to uncertainties due to boundary layer separation. This is not entirely unexpected, since it has been shown that a similar device, the nozzle Venturi tube, is also subject to similar instability for the same reason but at lower values of Reynolds number.

The characteristics of these devices are significantly different from that of the Nathan tube due to a different internal geometry. The juxtaposition of the two cones of this design causes the shape of the fluid stream into the device to be similar to that of a classical Venturi tube, with the result that the essential coefficient characteristic of that tube is maintained, but at a much higher Reynolds number. No doubt the absence of a parallel throat is also responsible for the shape of the curve which is inferior to that of the classical

design. For in this case the position of the low pressure tapping is at the end of the convergent section and not in the middle of a parallel throat. In this position it is subject to the pressure gradient caused by a separation of the stream from the solid boundaries of the cone. This effect is heightened by the divergent section which commences immediately following the pressure tapping plane.

Effect of Profile Roughness with Rough Pipes

The first series of tests were made using a rough test line and a smooth internal profile of each device. Since this arrangement has already been described earlier as a false condition, it was necessary to see the effect of a roughened profile on the points of instability and on the Reynolds number dependence shown by the first tests (Fig. 11).

Nathan Tube

Since this device consists of a convergent and divergent cone, two stages of investigation were required: the first was to determine the effect on general performance characteristics of a rough inlet section; the second to note the additional effect, if any, caused by adding a roughened outlet section. The results of these tests are shown on Fig. 5. Evidently roughness has made a remarkable difference: the curve due to the roughened inlet cone only has the characteristic normally associated with the classical Venturi tube, but without the usual hump.

There is less stability of coefficient and its value at or above constancy limit, has dropped by 4·5%. The constancy limit value $R_d = 300{,}000$ is lower also.

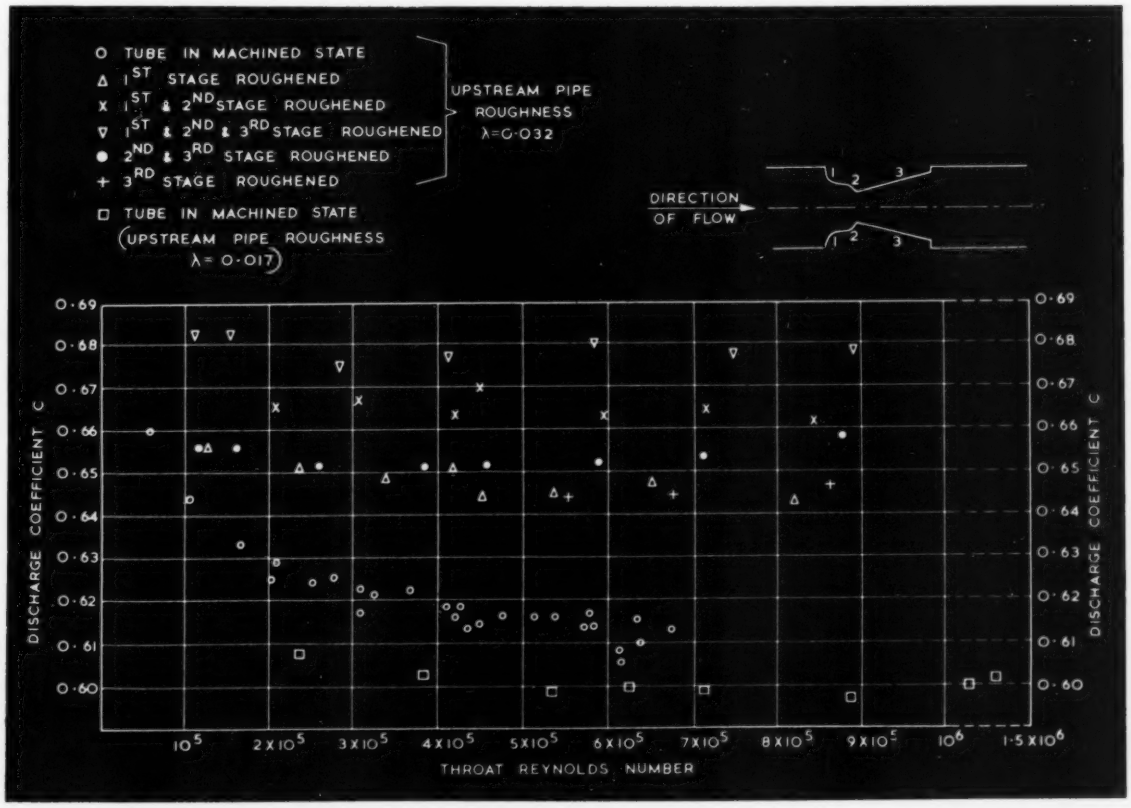
These changes are those expected by analogy with the classical Venturi tube. Schlag[3] has shown that even with a small area ratio ($m = 0{\cdot}25$) Venturi tube, a rough inlet or convergent section may decrease the value of C by about 1%. This effect has already been explained by Hutton[10], Engel[11] and others. The influence on C of velocity distribution or kinetic energy variation over the cross-section of a pipe or throat, is apparent by writing into the normal discharge equation terms which account for energy variation, thus:

$$Q = \frac{CA_2}{\sqrt{\alpha_2 - \alpha_1 m^2}} \sqrt{2gh}$$

where: C, A_2, h, g, have the usual meaning α_1, α_2, are coefficients to allow for energy or velocity distribution in the approach pipe and throat respectively, and are given by an expression of the general form

$$\alpha = 2 \int_0^1 \left(\frac{v}{V}\right)^3 \frac{r}{R} \cdot d\left(\frac{r}{R}\right)$$

Fig. 9. Rough pipe tests for an 8 in. Bopp and Reuther tube. Results of tests to determine the influence of internal profile roughness on the discharge coefficient. Average roughness height = 0·053 m = 0·586



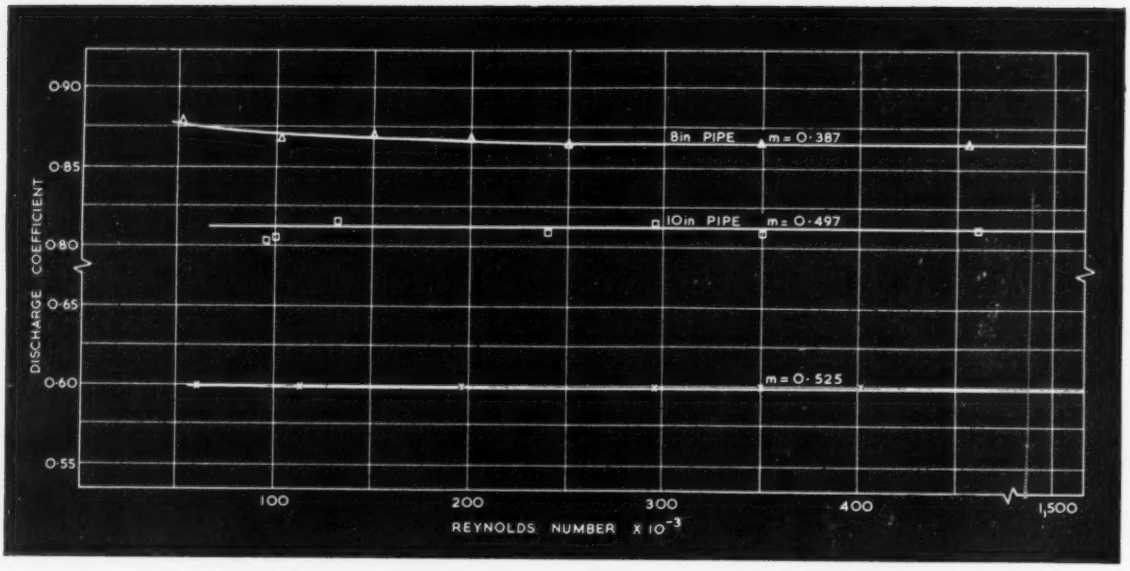


Fig. 10. *Discharge coefficients for smooth and rough pipes* ($0{\cdot}015<\lambda<0{\cdot}032$) *of experimental orifice plate*

In this expression v is a local velocity, V is a mean velocity, r is a particular local radius, R is the principal radius corresponding to the pipe or throat diameter.

It is normally assumed that $\alpha_2 = 1{\cdot}0$ because the velocity profile in the throat of a classical Venturi tube is uniform, i.e., that the fluid streamlines have almost equal velocity across the throat.

The case of α_1 is quite different: any variation in pipe roughness and any poor velocity distribution will affect the value of α_1. In fact it is not unusual to find α_1 expressed as a function of the friction coefficient λ.

In this case under discussion, the tests with a roughened inlet cone were made in the same pipeline used for the first tests. Therefore, there is no change in α_1 due to change in pipe roughness. But the con vergent stream into the device will be affected by the roughened cone wall and this will alter the velocity distribution in the plane of the low pressure tapping. Therefore, $\alpha_2 \neq 1$ and in fact $\alpha_2 > 1$ which causes a decrease in the value of C.

The second stage of roughening does not alter the actual characteristics of the curve very much, but merely displaces it upwards. This leads to the conclusion that roughening the outlet cone alone, causes a rise in coefficient values above those obtained for the tube in the clean state.

The reason is that the plane of maximum contraction is moved back slightly upstream of the throat tapping, due to the greater form resistance of the outlet cone. There is a resultant increase in throat pressure, and a decrease in the differential pressure which is equivalent to an increased value of coefficient.

Dall Tube

In this case the investigation into the effect of profile roughness had to be made in three stages to account for the major features of the design. The results are shown in Fig. 7. It is apparent that variation in roughness of the face of the step and of the divergent cone has little effect on the values and characteristics of the discharge coefficient curve.

The maximum deviation is caused by roughening the inlet cone after the step and is an increase in the value of coefficient. This is an unexpected result and can only mean that the throat velocity distribution is more even (decrease in α_2), or that the inlet cone roughness causes an alteration to the inlet velocity profile (increase in α_1) as far as the effect on throat pressure is concerned.

Since this result runs contrary to the effects of roughness on the convergent entry section of a classical Venturi tube, as noted by Schlag[6], it was decided to repeat the tests in the reverse order by removing the artificial roughness one stage at a time. As can be seen from Fig. 7, the effect of each stage is confirmed and it will be seen that the original machined profile data are restored when the last stage of roughening is still intact.

It does not appear from these tests that any major change in constancy limit occurs or in scatter of test points. There is some indication that the instability at $500<R_d<700{,}000$ is reduced by profile roughness. Nevertheless, it should be noted that the width of the band which encompasses these changes corresponds to a coefficient variation of only 3% — 4%.

Bopp and Reuther Tube

Here again the roughness tests were made in three stages corresponding to the essential features of the design. It appears that, for this device, the effects of profile roughness are serious. (Fig. 9.) In particular, the cumulative effect should be noted which results in a maximum deviation from the machined to a completely rough profile, in coefficient values of nearly 10%.

It is interesting to see that the slope of the machined profile coefficient curve is changed as the stages of roughness are added. This results in an apparent reduction in the constancy limit Reynolds number, but although there is a reduction in scatter of test points, the uncertainty as to a possible gradual increase in the value of coefficient should discourage the view that a reduced constancy limit has in fact been obtained.

The nature of the changes which are all increases in coefficient values are opposite to those associated with a standard nozzle. The rise in coefficients must be due to an increase in the value of α_1 which occurs with a more uneven entry velocity distribution, and/or to a decrease in the value of α_2 as a result of a more even throat distribution.

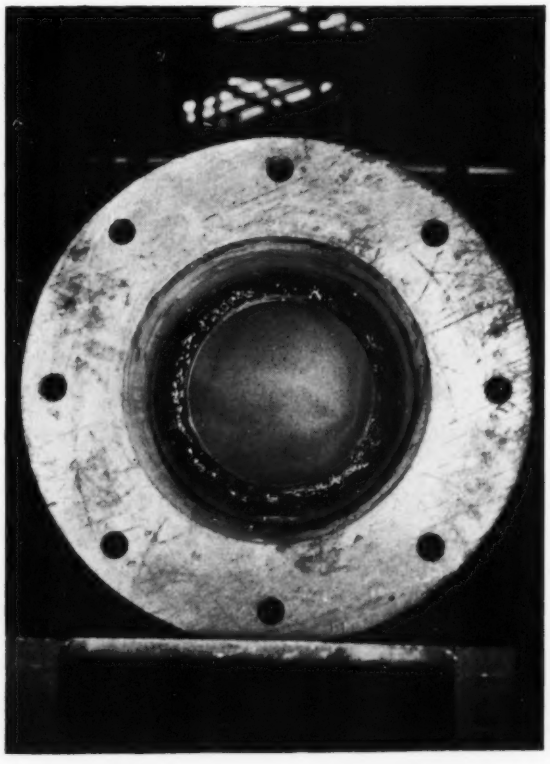
The explanation is to some extent borne out by considering the tests corresponding to first stage alone and third stage alone. The test points to all intents and purposes fall on the same line; in terms of α_1 and α_2, the roughness of each of these stages alone with the other stages in a machined condition are complimentary and can be expected to produce near enough the same coefficient.

One final point, the addition of roughness stage by stage indicated that the roughness of the divergent outlet cone has some effect on the coefficient values.

This is so unusual that the tests were repeated, for confirmation, in the reverse order by removing the artificial roughness stage by stage. When roughness had been removed from all but the divergent cone (third stage), there was still a residual plus deviation of about 5% from the machined profile values. This has to be compared with the results when stage three roughness was added after stage one and two; in this case an additional increase of only 3% was obtained.

The facts show that the observed influence of the divergent cone cannot be discounted, but that the extent of the influence depends upon the velocity or energy distribution at the commencement of the cone.

Fig. 11. *Photograph of typical profile roughness*



Experimental Orifice Plate

It has already been shown that the total effect of artificial roughness on the surfaces of an experimental orifice plate m = 0·524 is about − 2%. It seemed unnecessary therefore, to make a stage by stage investigation of the type already described for the other devices.

Comparison of Results

It seems from these test results that apart from the experimental orifice plate, these new devices are at least as sensitive as standard devices to the effects of roughness or deposit. By comparison, the experimental orifice is hardly affected, while the Bopp and Reuther tube is affected quite seriously.

It must be appreciated that the devices tested, all have high values of area ratio m and obviously these effects are more pronounced than they would be for smaller area ratios. Even so, the way in which these new devices are affected is interesting, particularly as far as the direction of error caused to the Dall and Bopp and Reuther tubes by outlet cone roughness.

Coefficient Tests with Smooth Pipes

Since the data so far obtained with the devices in a clean, machined state does not agree very well with that published, the whole programme of tests described above was repeated in a smooth pipe. In any case the analysis of the profile roughness tests have been made using the rough pipe/smooth profile curve shown on Fig. 3 and in view of the rather drastic results of these tests, it seemed right to establish whether the deviations noted were due to the rough pipe/smooth profile contrast.

Since the first series had revealed the characteristic trend of each device, it was possible in the second series to be selective and thus reduce the amount of test work.

Nathan Tube

The coefficient of discharge data are given in Figs. 4 and 12. A constancy limit R_d = 250,000 is clearly defined and there is a limited scatter of test points.

The characteristic hump of classical Venturi tubes is still apparent although of smaller amplitude. The change in value of the coefficient at or above constancy limit is as expected in that it compares in direction and magnitude almost exactly with that of a classical Venturi tube under similar conditions.

Dall Tube

The coefficient of discharge data are given in Figs. 4 and 13. Here again there is the expected reduction

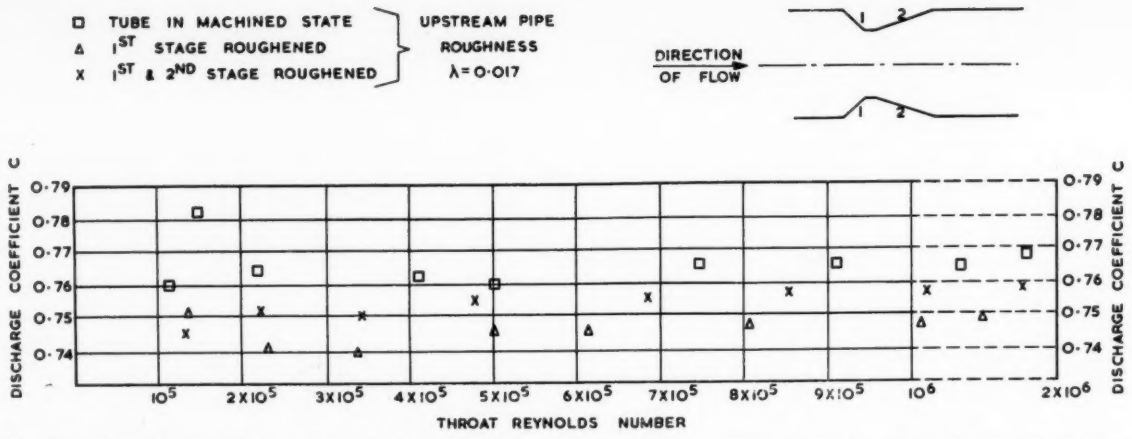


Fig. 12. *Smooth pipe tests on an* 8 *in. Nathan tube. Results of tests to determine the influence of internal profile roughness on the discharge coefficient. Average roughness height* = 0·053 $m = 0{\cdot}63$

in value which is quite limited compared with the classical Venturi tube, and also in the scatter of test points, but there is no reduction in the constancy limit value $R_d = 1{,}000{,}000$.

The reduction in coefficient values brings this tube into line with some forms of orifice and thus tends to explain the continuous rise in coefficient with decreasing Reynolds number in terms of the well-known characteristic of the square-edged orifice coefficient curve.

Bopp and Reuther Tube

The coefficient data are given in Figs. 4 and 14. Hardly any comment is necessary: the value of coefficient at and above constancy limit has decreased, but the constancy limit is probably the same although less well defined. The instabilities at $R_d = 400{,}000$ and 600,000 are less, which underlines the dependence of this type of device upon inlet distribution conditions.

In view of these particular remarks, it should be mentioned that in Fig. 14 the test points shown are representative of many tests, some of which have been omitted for clarity.

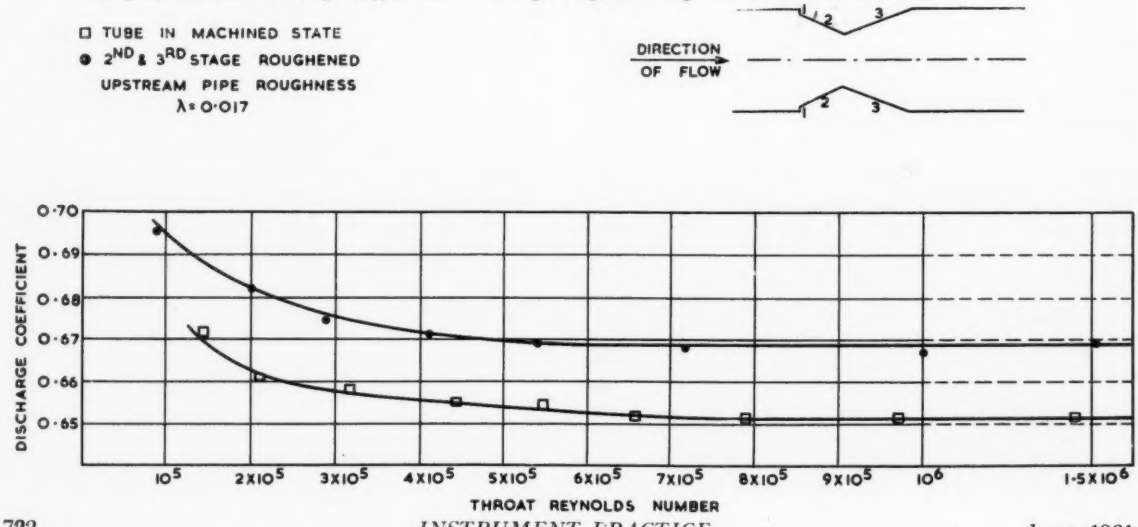
Experimental Orifice Plate

Previously it has been shown that this device is subject to pipe roughness influence to an extent not exceeding ± 0·6% and some further representative curves for either condition are shown in Fig. 10.

Comparison of Results

It is now possible to establish the relationship for the three tube devices between pipe roughness and Reynolds numbers in terms of coefficient deviation, as shown in Fig. 15. Although all three curves have a similar trend obviously the Nathan tube is much more subject to pipe roughness, that is to the influence of

Fig. 13. *Smooth pipe tests for an* 8 *in. Dall tube. Results of tests to determine the influence of internal profile roughness on the discharge coefficient. Average roughness height* = 0·053 $m = 0{\cdot}6065$



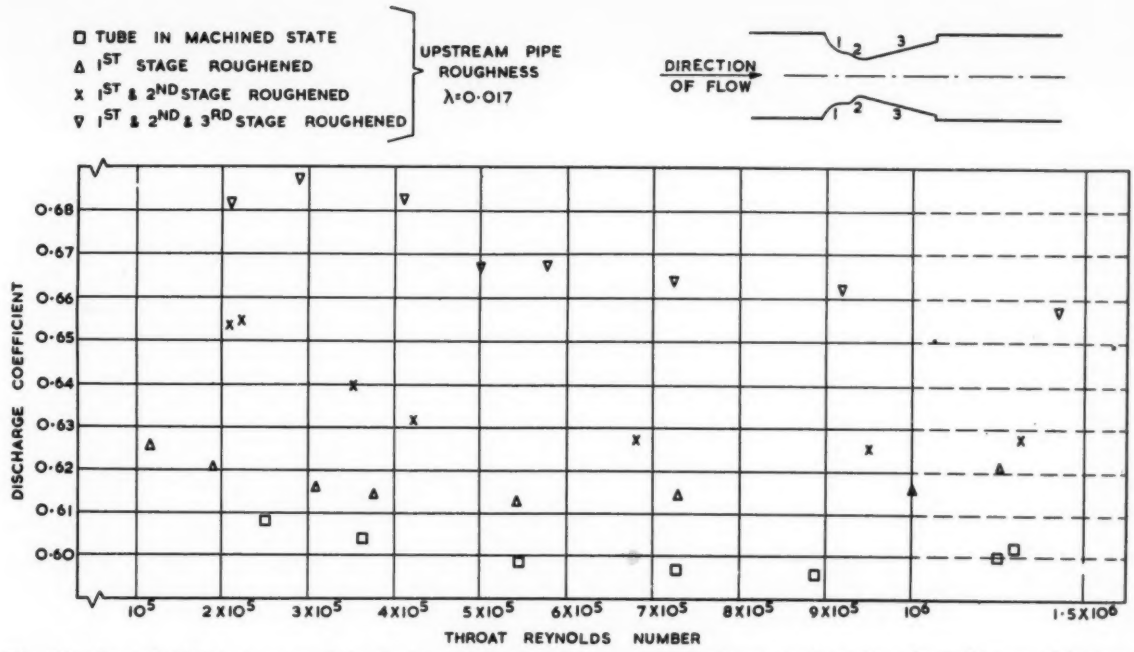


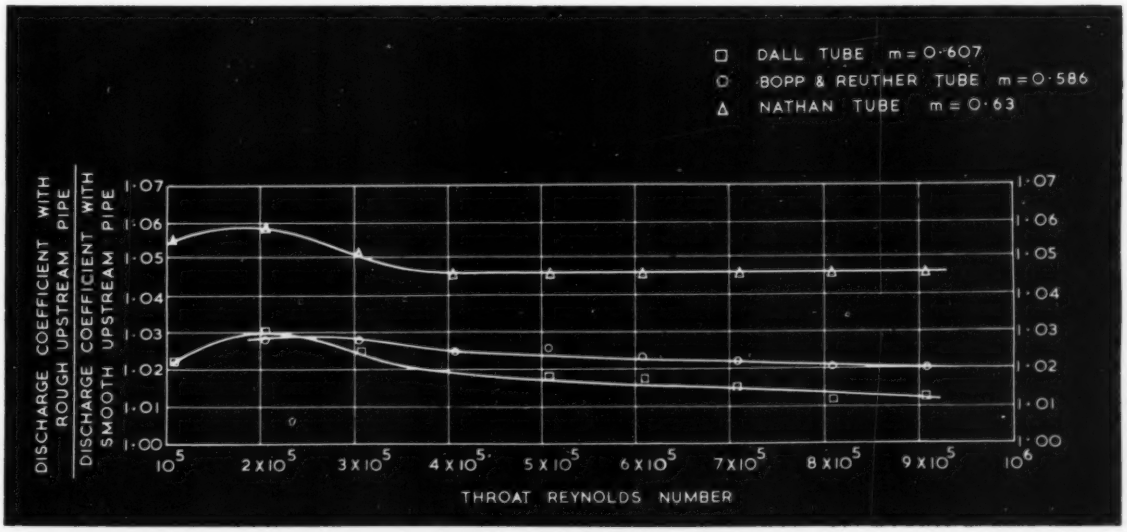
Fig. 14. *Smooth pipe tests on an* 8 *in. Bopp and Reuther tube. Results of tests to determine the influence of internal profile roughness on the discharge coefficient. Average roughness height* = 0·053 $m = 0{\cdot}586$

the kinetic energy factor α_1 discussed earlier. In fact, the magnitude of the deviation is the same as for a classical Venturi tube. The other two tubes show much less dependence on α_1, and since they are used at high Reynolds number, the limited deviation of coefficient due to roughness of between 1% — 2% is very satisfactory.

The slope of the curves applicable to these two tubes is due to the variation in α_1, α_2 and λ, and velocity distribution with Reynolds number. It is significant that these have not affected the Nathan curve as well.

No additional comments about the experimental orifice plate in this respect are necessary, except to repeat that its dependence on, or deviation due to roughness effects is about one third of that of the standard orifice plate.

Fig. 15. *Influence of upstream pipe roughness on discharge coefficient* *Upstream pipe roughness* $\lambda_1 = 0{\cdot}032$ *Upstream pipe roughness* $\lambda_2 = 0{\cdot}017$



Coefficient Tests: Effect of Profile Roughness with Smooth Pipes

Nathan Tube

As in the first series of tests, roughness was added stage by stage. The test results are shown in Fig. 12. Comparing with the previous data Fig. 5, it is clear that profile roughness effects for either stage singly or combined are reduced by almost 50%. This is due, as has already been said, to the inter-relation of the upstream velocity or energy distribution denoted by α_1, and the throat distribution α_2. The effect here has been for the reduced kinetic energy coefficient circumstances to react favourably on the throat distribution and thus reduce α_2 from the value obtained in the rough pipe tests. Therefore, although the roughness still leads to a reduction in coefficient value compared with the machined state the magnitude of the reduction has diminished. General characteristics such as scatter, stability and constancy appear to be virtually unchanged.

Dall Tube

The previous tests had shown that only the second and third stage roughness was of importance. In the present tests it was thought necessary to consider these stages only. The test results are shown in Fig. 13. As before, the effect is opposite to that on the classical Venturi tube, but there is a slight reduction in the magnitude of deviation. There is however, still the same tendency for the deviation to increase with Reynolds number. In which case the explanation given in the rough pipe series still holds, and it is sufficient to add that in other general respects there is no obvious change due to upstream pipe influence. Except perhaps in the matter of scatter, which seems improved and in the less rapid rise in coefficient values at $R_d > 200{,}000$.

Bopp and Reuther Tube

The results of three stages of roughness are shown in Fig. 14. Comparing these with the data in Fig. 9 shows that although there is now for the first and second stages a reduction in magnitude, there is no general improvement in the overall deviation.

Furthermore, there is a serious deterioration in repeatability and stability at $R_d > 500{,}000$ and again at $R_d > 900{,}000$ as represented by the scatter of test points and the trend of the curves; and there is no longer any tendency for the constancy limit to be lowered as was indicated by the tests on Fig. 11. Again contrary to the classical Venturi tube all stages of roughness increase the coefficient. The reduction in the magnitude of this increase for the first and second stages, indicates that inlet velocity distribution plays a more than usually important part in the performance of this and similar devices.

Once again, it should be remembered that the tube tested had a high area ratio $m = 0{\cdot}586$, and that tubes of smaller (and more often used) area ratio would be less subject to these changes.

Experimental Orifice Plate

The dependence of this device on profile roughness has been stated earlier to be not more than 2% and this error has been found to be virtually independent of upstream pipe roughness.

Comparison of Results

These series of tests confirm that upstream pipe roughness is a major influence on the performance of the three tube devices. This is understandable, since all three rely for their special character, upon an abrupt change to the inlet velocity distribution.

Of the three, the Nathan tube profile causes a much gentler change and this is reflected by the coefficient values obtained. It also explains why the coefficient is more dependent upon the upstream pipe roughness state. The Dall tube and Bopp and Reuther tube provide an interesting contrast. The latter makes an important modification to the velocity distribution and boundary layer condition at a point well within the device. It is not surprising therefore, that it appears (from these tests on one device) to be much more sensitive to variations in pipe and profile roughness. The fact that the inlet section is a nozzle may enhance this, since it is known that the nozzle characteristics are uncertain and subject to some instability under certain dynamic conditions.

In the Dall tube design, no modification occurs so far within the device although the general characteristics are very similar to those of the Bopp and Reuther tube, except that the higher constancy limit must be regarded as a distinct disadvantage. Moreover, the abrupt modification to the inlet distribution is obtained simply by using a step which is akin to an orifice plate and which will thus have similar stability. It is easy to see that this design will effect an abrupt and yet more positive redistribution of energy and this is borne out by these tests which show limited dependence on upstream velocity distribution.

The tests for profile roughness influence and the general lack of instability, also suggests that the Dall tube effects an easier compromise adjustment to throat energy distribution.

In an earlier paper, the author made the point that any device which modifies the inlet velocity profile by means within the device must have a generally inferior performance to that of standard devices. The experimental orifice design makes the profile modification before the orifice face is reached, and the low constancy limit and sensitivity to pipe and profile roughness are the result.

The Dall tube is an intermediate stage between the desired external modification process and the less satisfactory internal modification method of which the Bopp and Reuther tube and the Foster flow tube are examples.

These tests underline the difficulty of obtaining workable calibration data for normal commercial use, unless care is taken to ensure that the relative roughness of both pipe and device are known with some certainty.

Commercial pipes are not generally smooth and the data given here shows how unreliable it is to use information for these types of devices obtained in a rough pipe with a new, clean and machined profile.

References

1. B. A. Bakhmeteff. "The Mechanics of Turbulent Flow". Princeton University Press, 1936. (New Jersey).
2. L. F. Moody. "Friction factors for pipe flow". *Trans. A.S.M.E.*, Nov., 1954, pp. 671-680.

3. A. SCHLAG. "L'influence de la rugosité sur le coefficient de débit des appareils deprimogenes". *Rev. Universelle des Mines*, 9th Ser., **6** (1950), pp. 111-118.
4. R. WITTE. "Neue Beiträge zur internationalen Normung auf dem Gebiete der Durchflussmessung". *Brennstoff Wärme*, **5** (6), June, 1953, pp. 185-190.
5. A. SCHLAG. "Survey of studies of classical Venturi-meters at the University of Liege". Paper C.2. Symposium on Flow Measurement in Closed Conduits. National Engineering Laboratory. East Kilbride. Sept. 27th-30th, 1960.
6. E. A. SPENCER and G. THIBESSARD. "A comparative study of four classical Venturi-meters". Paper C.3. Symposium on Flow Measurement in Closed Conduits. National Engineering Laboratory, East Kilbride. 27-30th Sept., 1960.
7. I. O. MINER. "The Dall flow tube". *Instrum. Engr.*, **2** (3), April, 1957.
8. A. A. KALINSKE. "The twin throat Venturi: a new fluid flow measuring device". *Trans. A.S.M.E.*, Jan., 1930. Paper No. 59-A-154.
9. E. SCHRODER. "Velocity and wall-pressure distributions in standard and "Twin Throat" Venturi-meters". Symposium on Flow Measurement in Closed Conduits. Paper D-3. East Kilbride. (N.E.L.). 27th-30th Sept., 1960.
10. S. P. HUTTON. "The prediction of Venturi-meter coefficients and their variation with roughness and age". *Proc. Inst. Civ. Engrs*, **3** (1), 1954, pp. 216-241.
11. F. V. A. E. ENGEL and A. J. DAVIES. "Velocity profiles and flow of fluids through a contracted pipe-line". *The Engineer* (Lond), 30th Dec., 1938.

British Non-Ferrous Metals Research Association

AT the Annual General Meeting held by B.N.F. recently the opportunity was provided for looking round the laboratories and seeing some of the many research activities of the Association.

High Speed Testing of Tubes

At present many specifications for copper alloy tubes demand that the tubes should all be hydraulically tested, which is consuming inspection process. The use of eddy currents to detect cracks and manufacturing faults in tubes is more sensitive and enables inspection to be carried out automatically at high speed.

The instrument designed by the Association based on this technique has reached the development stage, and the "drag" effect which occurs when products moving at high speed are inspected by eddy current testing methods have been minimised. The equipment can be set so that good tubes fall on one side and rejected faulty tubes fall on the other side.

Measurement of Plating Thickness

Two new gauges have been developed by the B.N.F. for measuring accurately and quickly the thickness of plating. One of these—the B.N.F. plating gauge is a non-destructive gauge developed specially for measuring the thickness of nickel plating for routine inspection purposes, based on the thermo-electric effect.

A new coulometric instrument which measures plating thickness destructively has also been developed to the point of commercial production.

The principle on which the gauge is based is Faraday's Law and the instrument is much simpler than others of the same type on the market and has proved successful not only in checking standards for the non-destructive thermo-electric gauge but also in measuring chromium thicknesses which are difficult to determine by other methods.

Automatic Analysis

The B.N.F. has been a pioneer in the introduction of the X-ray fluorescence method of analysis into the metallurgical industry in this country. With this technique a piece of metal is irradiated with a beam of X-rays and the secondary X-ray emission, which is characteristic of the elements present in the alloy, is analysed with a special spectrometer. In this way a quantitative analysis of the alloy can be obtained rapidly, and commercial instruments are now available which allow a complete analysis to be made in a minute or two, the results being recorded on a paper tape. These great savings in analytical time have production advantages; for example melts may be analysed while the metal is held in the furnace and the charge composition adjusted before the billets are cast.

Temperature Measurement

A major difficulty in the use of radiation pyrometers for temperature measurement is the error arising from variations in surface emissivity under production conditions; these variations are particularly troublesome with aluminium alloys at hot-working temperatures and with inductively heated copper alloy billets which oxidise during heating. A method of correction using a heated reflector plate to obtain more nearly black-body conditions, which was developed previously in the B.N.F. Laboratories, is now about to undergo trials for measuring slab temperature in an aluminium rolling mill.

Limitations of space, however, often prevent an instrument of the radiation type being used, and for measuring the temperature of extrusions close to the die a roller-contact thermocouple is now under construction for industrial trials. Consideration is also being given to the possibilities of the method of "piping" radiation to the meter from a point on the product where access is difficult.

Recent Trends in

INDUSTRIAL FLAME FAILURE SYSTEMS

by P. R. PRIOR, M.S.M.A. (Honeywell Controls Ltd.)

Introduction

MUCH has been written on the subject of industrial combustion safeguard systems and it is not proposed, therefore, to describe here at great length equipment that has been known and used for many years. However, this subject is of sufficient importance to designers, manufacturers and users of industrial plant employing combustible materials or fuels, that it is felt some discussion of recent trends and developments is pertinent.

For the less initiated it is perhaps in order to state here that the control systems referred to are primarily equipments for sensing the presence of flame in combustion chambers and of ensuring that the fuel is only supplied to the burners concerned in a proper manner and at the proper times. Over the last twenty-five or thirty years certain techniques have emerged but even today new methods are constantly being tried in an attempt to make such systems even safer and more efficient.

Why Have Flame Failure Systems?

The main reasons for considering flame failure systems for fuel burning plant are four in number namely:

(a) For the protection of life
(b) For the protection of plant and production
(c) For economy of labour
(d) As part of a general move towards automated plants.

The first reason, still probably the most important, was the original basis for considering combustion safeguards. From the early days of the use of fluid forms of fuel it has been recognised that some device which automatically shuts off the fuel supply valve in the event of a failure of the flame, is absolutely essential to avoid the explosion hazard due to ignition from refractory, incandescent soot in flues, etc., or from an ill-advised operative attempting to re-ignite without purging his combustion chamber. The second reason is an extension of the first, of course, and is an acknowledgement (particularly by insurance companies) of the fact that very costly plant can be damaged and put out of action for long periods should an explosion occur with resultant loss in production and profits. The third reason is a more recent development and enables users of modern highly developed plant (which needs a supervised start-up programme which can be combined with the duties of flame failure sensing in these control systems) to avoid the necessity of hiring and training specialised personnel to operate the plant. The move towards complete automation with computer control of process plants, implies the need for reliable flame signalling and programming as an essential part of start-up, operation and shutdown of unmanned plants such as boiler-turbine units in power stations and so on.

Flame Sensing Phenomena

Phenomena that have been used for flame sensing include temperature, electrical conductivity, electrical rectification, emission of light (visible, infra-red and ultra-violet) and of sound. The choice of phenomena to be used depends of course on many things, but the trend has been to find one which is universally applicable.

Simple flame failure devices are made to-day using the temperature characteristic wherein a thermopile or single thermocouple is used to operate a shut-off valve directly or through an amplifier or to operate a relay in an electrical circuit, and such control equipments are possibly the least costly, have the least bulk and are extremely reliable. They lend themselves, therefore, for application to the small gas fired oven or similar equipments, and particularly where a large number of small burners are involved. These equipments are ideal as the more sophisticated electronic devices are

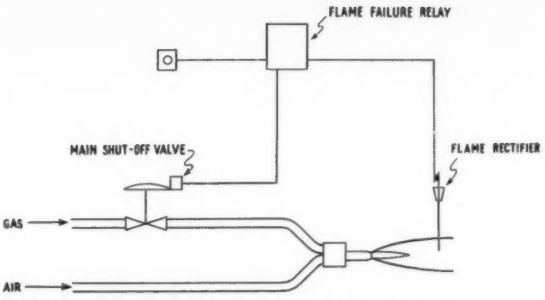


Fig. 1. Diagram of simple cut-off hook-up, for non-piloted manually ignited burner

precluded because of cost. By keeping circuit resistances very low, the thermo-electric effects are sufficient to energise the control circuit. On the other hand, the metal mass of the thermocouple or thermopile should be small to give sensitivity and, therefore, rapid shut-down. Since these two requirements are incompatible, the device has some limitations in this respect. In spite of this many hundreds of this type of equipment are used on gas fired boilers for domestic home heating and are successfully in operation on the smaller industrial plants.

Many years ago the value of electronics was recognised and early equipment utilised the fact that any flame has an ionised envelope which conducts a small current. By using an electrode which is in contact with the flame while it is established, and applying a d.c. voltage to the electrode, the small current that results when the flame is present, is amplified and used to operate relays in the safety circuits. However, this system has serious shortcomings in that any high resistance leak to ground in the electrode circuit simulates a flame, and very great care has to be taken when installing the components. In more recent times, an extension of this principle has become almost universal namely that of flame rectification, since it has been found also that a flame could be used to rectify an alternating voltage applied to the electrode, and this method is in use wherever combustion conditions permit.

Photo-electric cells have similarly been used for many years, and various types are in operation. The two most common types are the photo-conductive cell which varies its resistance on exposure to light, and the photo-emissive cell in which the emission of electrons between two electrodes varies with exposure to light. For combustion safeguard work, photo-emissive cells are usually gas filled, since they have a greater sensitivity. A later development of these cells using lead sulphide, has provided a cell sensitive not to visible light but to the infra-red region, and a further development to be described later uses a cell sensitive to the ultra-violet region.

Modern Systems in Use

The most simple type of control system currently in use is the straightforward cut-off flame relay where a manually ignited burner is supervised during its normal running period, and, should the flame disappear for any reason whatsoever, the control detects this and closes the supply valve thereby requiring manual re-starting. The number of systems now manufactured that will serve this purpose are too numerous to mention, but a typical application of this type is shown in Fig. 1. Such systems would be found in use on many types of plant, and are applicable universally where the burner control sequence is not complicated and where labour is available for start-up and for routine inspection. Such applications might include small batch ovens for drying paint, etc., simple single burner dryers, dye casting metal pots, and so on, and can be found using flame rod, photocell and infra-red type sensors.

Semi-automatic system

A development of this simple system is the semi-automatic control which is used on a single burner firing either gas or oil where a pilot is used and where start-up is instigated manually and is either by hand, torch or spark. Such systems have, generally speaking, to prove the pilot before permitting the ignition of the main burner and on flame failure would have to shut-down pilot and main valves and give an alarm. These will be found in use on the larger versions of the plants previously described, some low temperature furnaces, galvanising bath combustion systems, etc. Again the devices used for sensing a flame will be any of those previously mentioned depending on the flame itself and combustion conditions, and these controls will also usually have a number of safety features. Such features include safe start check circuits which will not allow the control to open any valves on an attempted start if it senses a flame, or if any flame simulated fault has occurred in the control since it was previously in use. It is now also general practice to build into such devices a timed ignition, with lock out such that if on an attempted manual start, the pilot flame has not been established within a definite period (usually between 15 seconds and 45 seconds for gas) then the device locks out, that is to say closes the valves, removes the ignition source, and has to be manually reset. Some devices give a separate signal to this effect when this condition occurs.

Fully Automatic Control

The next step in developing these systems is the fully automatic or fully sequencing control, and this is becoming more and more necessary in these days of automatic plant. Such a control would achieve the same object as the semi-automatic control, i.e., the proper establishment of flame, together with the constant supervision of the flame, and in addition will provide necessary functions for the combustion system as a whole such as pre-purge, post-purge, etc. When connected in with the combustion control circuit, the circulating fan circuit and the limit controls, such systems represent the most safely supervised control, and are necessary on such equipment as fully automatic shell boilers for heating of buildings and provision of process steam and hot water, and on the larger industrial furnace plants using high intensity burners. Sequencing devices of this type have been in use for a year or two on gas piloted fully automatic oil burners. A typical sequence includes pre-purge, establishment

Fig. 2. Typical sequence control utilising infra-red sensor

of ignition spark, opening of pilot valve, trial period for establishment of pilot flame, and if successfully established, opening of the main valve with a further period for the establishment of the main flame before removal of spark ignition and, after flame failure, a post-purge to clear the main burner and its nozzles of oil. There are many variations to such a programme depending on the burner and plant requirements, and in more recent times, the design of high intensity pre-mixed gas fired burners of the totally enclosed combustion type also requires a similar programme and similar controls accordingly. Fig. 2 shows a typical sequencing control of this type with its associated detector, in this case an infra-red sensitive cell.

Multiple Burner Systems

Multiple burner systems are frequently needed and one has the choice of individually protecting each burner by one of the methods described above, or alternatively providing an integrated control system, and selection is usually determined by the plant and its method of operation. For example, an installation of four oil fired heating boilers feeding a common heating system for a large office building and each having a single pressure jet oil burner, is better controlled independently or sequentially with four separate photo-electric cell operated controllers, generally similar to the type shown in Fig. 3, and such sequencing as is necessary can be carried out on the temperature control cycle.

Alternatively, a metal treating furnace, running at temperatures low enough to justify combustion safeguards, having say four high intensity gas burners, and a common temperature control system, would be better started up to a definite sequence and each burner started in the low fire condition, and all burners established before allowing the temperature control to increase the firing rate. In this case, it would generally be necessary to engineer specially such systems to the individual plant concerned. The plant requirements would similarly determine whether on the failure of one flame the whole plant is shut-down or merely whether that burner itself is shut-down and/or recycled.

Recent Developments

Recent achievements can be divided into two main categories, those of equipment and application. Firstly in respect of equipment, recent developments concern the basic sensing device in flame failure systems.

Infra-red Sensor

One manufacturer is now offering an infra-red sensitive photo-transistor as the basic sensor, which can be used generally in the same way as lead sulphide cells of the tube type, but which has the inherent advantages of semiconductor devices such as immunity to vibration, small bulk, long life, etc. This sensor can be used to operate simple cut-off devices or the more sophisticated full sequencing controls such as the one in Fig. 2.

Ultra-violet Sensors

A second development in recent times is the use of barrier layer photocells, which are of a type which generate a signal on being exposed to light in the visible range. One make of control now uses a selenium barrier layer cell which, it is claimed, is substantially insensitive to infra-red radiation and which obviates the use of flicker amplifiers. The device shown in Fig. 3 operates on this principle.

Fig. 3. Another type of sequence control using barrier layer photo-cell type sensor

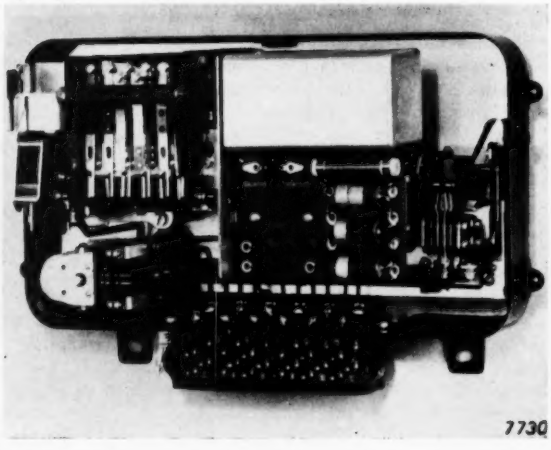


Fig. 4. Typical single burner control using all solid state techniques

A further development in respect of basic sensors is the ultra-violet detector illustrated in Fig. 4 which depends for its operation on a tube of the pulsing variety similar to a Geiger Müller tube and which, by its design, is sensitive to ultra-violet radiation. Receipt of ultra-violet radiation in the range 2,600 – 1,950 Å causes pulses of current to travel from the cathode to the anode when under high electrical d.c. potential. Such pulses are controlled by means of a multi-vibrator circuit to prevent tube damage. The output of the pulsing circuit is integrated, and used to control a simple rectifier of the tube type such that when the head is presented with alternating current, it will rectify when flame is present and will not when flame is absent, that is to say will operate with standard rectification type relays.

The advantages claimed for this device are that, being sensitive only to ultra-violet, it is not effected in any way by refractory brickwork since no ultra-violet radiation is emanated by hot refractory or indeed any source likely to be met with in combustion systems where actual combustion is not taking place. In addition, since ultra-violet radiation is not attenuated to any great extent, distance is not a critical factor. This compares very favourably with infra-red devices which can discriminate between flame and brickwork, because the former emanates a pulsating radiation while the latter radiates a steady signal. Nevertheless, dangerous conditions can arise due to modulation of the steady signal by movement of gas, brickwork shimmer, etc. Loss of sensitivity due to high background steady radiation is also avoided.

In connection with the control relays themselves, certain developments have taken place recently, not least of these being the move towards solid state devices with the elimination of thermionic tubes and therefore the avoidance of warm-up time, tube failures due to inter-electrode defects, ambient temperature problems and corresponding maintenance costs. A typical new solid state control is illustrated in Fig. 4.

The development of the cadmium sulphide photocell, which is of the photo-conductive type, has assisted in the development of control relays which do not employ amplifiers. The cadmium sulphide cell can be made very small in size, and is therefore ideally suited to those applications where space in or about the burner is at a premium. It also has a comparatively low resistance, passing a current of sufficient value to operate a relay directly. The elimination of amplifiers in these systems, incorporating relays directly operated by the cells, represents a major development.

In the field of standard rectification type relays as used industrially, and employing tube type amplifiers, a further development of the self checking feature was recently introduced by one manufacturer. Whereas most controls of this type, as mentioned previously, carry out a component check on start-up, there are some failures that can occur, such as a grid to cathode, or grid to anode short, which cannot be recognised during the normal running period of the device. A hazardous situation would therefore arise if flame failure occurred as the device could not recognise this, since the valve would continue to pass current, the triode acting as a diode. This new development is

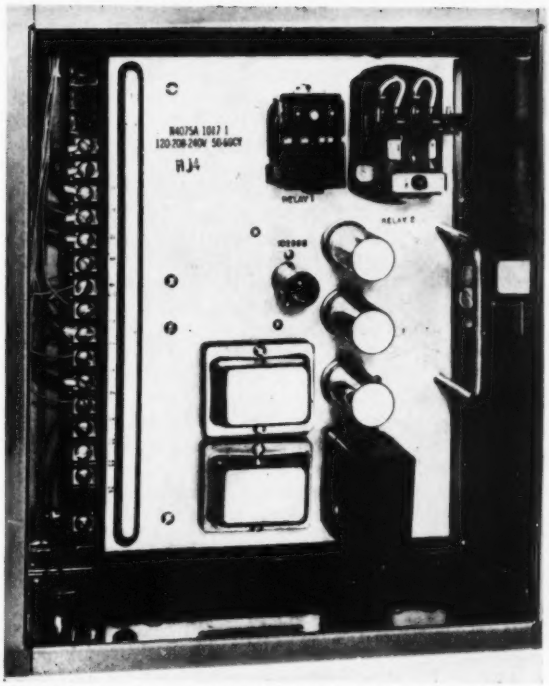


Fig. 5. Maximum safety is achieved with this continuous self checking control

primarily used on industrial plants where once the burners are lit, they are often in use for many days or even weeks, but has less application on cycling type oil burners where the conventional control can carry out its normal component check on each cycle of the thermostat. The new industrial control operates in such a way that the incoming signal from the sensor to the electronic network is pulsed by a relay contact on the flame relay itself, and, provided a flame is present, the circuit oscillates because of the feedback. A further contact on the pulsing flame relay is used to operate the control relay in a d.c. system through a resistor-capacitor " cup and bucket " circuit such that failure of the relay in either the energised or the de-energised position will cause shut-down, pulsing being necessary to maintain the valves in the open position. This relay is claimed to be the only 100% safe combustion safeguard control and is illustrated in Fig. 5.

In the field of application of these controls, certain recent achievements are worthy of mention.

The ultra-violet sensor referred to has found one important application with respect to exothermic gas generators. The generators are normally of the type where town's gas or a similar combustible is partially burnt under controlled conditions to produce an atmosphere for furnaces having definite characteristics such as a known carbon content, etc. The partial combustion of these gases takes place in a confined combustion chamber with, of course, the minimum of air and normally at high temperature. Flame rods are generally quite unacceptable for detection due to the high temperatures; photocells are ineffective because of insufficient light emission, and the standard

method in the past has been to utilise an infra-red detector. However, much care has had to be exercised in the application of these detectors so as to avoid high level background radiations from incandescent brickwork which is present due to the design of the generators, and to avoid the possibility of radiation modulation by shimmer effects, etc. Thus the applications were in some cases troublesome and difficult to achieve without critical adjustments. The ultra-violet detectors, however, can be sighted at the flame irrespective of the background and care need only be taken to ensure that the flame is viewed at all times that it is present, and that the detector is mounted such that it will be physically in a safe position and in conditions of ambient temperature that are acceptable to it.

The ultra-violet detector has also been applied to flare stacks on refineries with much success. Conditions of weather, sunlight and other effects, not to mention high ambient temperatures in semi-tropical locations, have caused problems in the past.

Perhaps the most interesting application of the ultra-violet detector in recent times has been to large power station boilers for proving oil or pulverised fuel flames. The current trend in automatic control of these large boiler/turbine units developing up to 200 megawatts, is towards greater automation and less reliance on manual functions. Indeed, computer control of hot start and shut-down has already been achieved, and complete automation of these plants is envisaged in the near future. However, one essential part of such systems is the reliable signalling of flame condition, and inaccurate advice of flame failure must be avoided at all costs because boiler shut-down under these conditions is a most expensive procedure, and must not be carried out unnecessarily. In the past, photo-electric systems have been applied successfully to the large oil burners used on these installations, normally on a single burner independent system basis and, in this case, the ultra-violet detector can offer advantages only in respect of target size and flexibility of application. However, in the field of pulverised fuel burners, it has been most difficult in the past to find a reliable flame reporter that will continue in operation over a long period. The problems arise from the nature of the fuel which causes a less stable flame to be available for viewing, the amount of target area necessary for photo-electric devices, the frequent sooting up of sight windows and in certain cases the screening of visible light by unburned coal powder. Recent tests with the ultra-violet detector has shown it to be very successful under these conditions, and in most cases, pulverised fuel burners can be successfully monitored.

Future Trends

In general terms one would think that the rapid development of this particular branch of the automatic control industry would continue in the future years, generally along the lines one would normally expect, that is to say, simplification of devices, improvements in reliability, and cost reduction. The trend towards non-amplifying devices will obviously continue and a search for the truly universal sensor which can be used under all conditions and for all fuels will continue, a satisfactory economical answer to this problem having not yet been found. It is also to be expected that other phenomena may be tried for the sensing of flames such as pressure or differential pressure in combustion systems, radiated heat on thermopiles or other such devices, and possibly even a development of a system offered by one manufacturer using the sound emission from burners. The design of newer and more complicated sequencing devices will no doubt continue, and it is to be expected that a phase of a large number of complicated controls will have to be lived through before a common design can be envisaged.

These devices and this industry are obviously undergoing rapid changes and developments, and, like most young activities, will no doubt go through periods of failure as well as success.

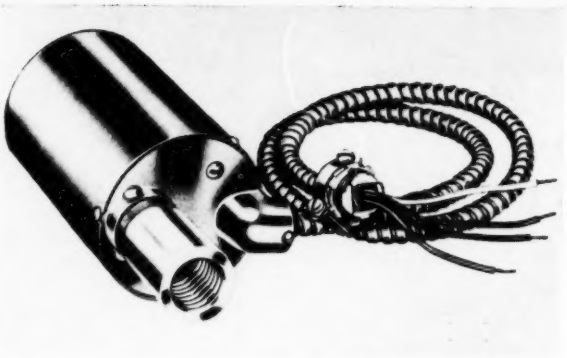


Fig. 6. Ultra-violet sensing head insensitive to visible and infra-red light

Acknowledgements

The author gratefully acknowledges the assistance given by Messrs. Fireye Controls Co. Ltd., The Stonebridge Electrical Co. Ltd., and The Rheostatic Co. Ltd., in the preparation of this article.

RADIO TELESCOPE

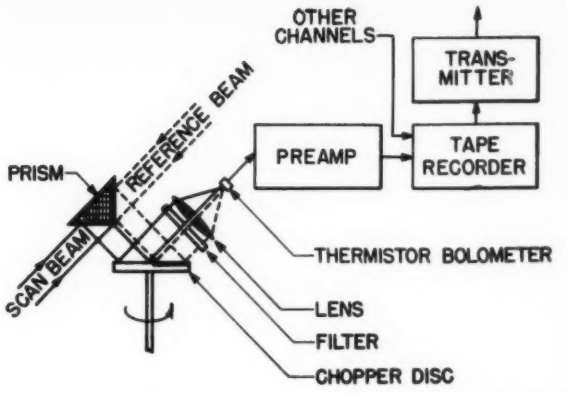
A fully-steerable radio telescope is to be built at a site near Crowthorne, Berkshire, by the Ministry of Works for the Radio Research Station of the Department of Scientific and Industrial Research. It is expected to be completed and in operation towards the end of 1963 at an estimated overall cost of £250,000, including buildings, equipment and site services.

The radio telescope, which will have a parabolic aerial about 80 ft in diameter, is needed by D.S.I.R.'s radio scientists for their work in the space research programme and to study certain other aspects of radio science.

It will have high accuracy and a faster tracking speed than the 250 ft radio telescope at Jodrell Bank, an essential requirement for following earth satellites and determining orbital data. It will be used to receive weak signals from distant space vehicles transmitting at ultra-high frequencies.

WEATHER SATELLITE

uses infra-red methods



Block diagram of Barnes 5-channel infra-red radiometer

TIROS II, sponsored by the U.S. National Aeronautics and Space Administration, is the latest in a series of weather observation satellites that are now in orbit. Containing a series of equipment, the new satellite will yield photographic data from television cameras, and also infra-red measurements of the Earth's temperature and cloud cover. Combined, these data will provide the U.S. National Aeronautics and Space Administration and the U.S. Weather Bureau with statistics, useful for developing greater reliability in weather forecasting.

Horizon Sensor

Collection of this information is assisted by three infra-red devices, built by Barnes Engineering Co. in Connecticut. One of them is a horizon sensor, which helps to establish a line of reference, so that scientists will know the angle between the weather satellite axis and the imaginary perpendicular to the Earth. This factor is useful if photos and other data being telemetered to ground stations are to be interpreted rapidly.

Infra-red radiation received from the Earth in outer space comes from two sources: diffusely reflected radiation from the sun, and thermal self-emission of the Earth and its atmosphere. Because practically no radiation is received from space—stars and other planets are too distant to have any effect—there is a discontinuity in radiation intensity at the horizon. This sudden drop (or rise) is detected by the horizon sensor and used to establish the local vertical, a line aimed straight at the centre of the Earth. Similarly, any angular deviation from this vertical is measured by the horizon sensor, and results in a changed output voltage which can be telemetered to the ground for interpretation.

Because the satellite is space-oriented like a gyroscope, its cameras will actually point toward the Earth only during a part of each orbit. At other times, the cameras will see merely a part of our planet, and during more than half of each orbit the camera lens will be pointed into outer space. Knowing prevailing conditions, as indicated by the horizon sensor, the monitoring ground station can turn the cameras on or off, to preserve the power supply.

Radiometers

The other two infra-red devices aboard the satellite are meteorological radiometers. The Meteorology Branch of the Goddard Space Flight Centre of the U.S. Aeronautics and Space Administration planned and engineered the meteorological data gathering system in the Tiros satellites, while design and construction of the infra-red radiometers described was undertaken by Barnes Engineering Co. under the sponsorship and direction of the Signal Corps and the U.S. National Aeronautics and Space Administration. One of these instruments is a 2-channel non-scanning radiometer—aimed along a fixed axis, parallel to the cameras of the satellite. Its view corresponds roughly to that of the wide-angle TV camera, a 50° by 50° field.

Its companion is generally referred to as a scanning radiometer. It is a 5-channel instrument, with a 6° by 6° field, approximately that of the narrow-view TV camera.

The field of both radiometers is fixed with respect to the satellite; they scan only because of the satellite's own motion.

These two radiometers are used to determine the temperature of the Earth, temperatures existing near the middle of the atmosphere, cloud-top temperatures and distribution, as well as the Earth's efficiency in absorbing solar radiation. All these are expected to have a definite relation to weather generation and movement.

5-Channel Radiometer

The 5-channel radiometer in Tiros II has five separate detectors, designed to cover specific wavelength ranges, and accomplish the purposes shown in the Table.

Each channel is capable of looking in both directions, but alternately rather than at the same time. Infra-red radiation as well as visible light entering each channel of the radiometer head from either side is deflected 90 degrees by a prism, and is reflected from a chopper mirror, then passes through a lens and filter assembly before being absorbed by the thermistor detector.

Coated with infra-red absorptive paint on half their area, rotating mirrors stop infra-red energy received first from one, then via the other side of the prism.

Channel Wavelengths and Functions of 5-Channel Scanning Radiometer

Channel	Wavelength range micron	Function
1	6·3 ± 10%	Strong water vapour emission. Yields temperature near middle of Earth's atmosphere.
2	0·55 to 0·75	Visible range. Detects nature of cloud cover in the daytime. Response close to that of human eye, and serves as reference for infra-red channels.
3	0·2 to 5·5	About 99 per cent of solar radiation falls into this band. Channel measures albedo of the Earth (energy from the sun striking the Earth, but not absorbed).
4	7·5 to 30·0	Measures Earth's total emission, i.e., temperature of Earth as viewed from the satellite.
5	7·5 to 12·0	Atmospheric window. Measures temperature of the Earth or its cloud cover. Looks through atmosphere in area where water vapour absorption and emission are low.

This alternate reflection and absorption by the rotating mirror has the effect of creating an a.c. signal. This signal, developed by the thermistor detector, is then amplified, rectified, and stored on magnetic tape, for playback at command.

In space, the two radiometer windows will generally be oriented so that one of them looks towards the Earth, the other into outer space. Because outer space temperature is constant, it will be used as an absolute reference point against which to calibrate indications of the Earth's temperature (radiation).

2-Channel Radiometer

The 2-channel d.c. radiometer weighs 1½ oz, and requires only 50 microwatts to operate. Because of this low weight, the satellite's builders were able to include the additional instrument without affecting the payload-carrying capacity of the Thor-Delta launching vehicle.

This radiometer will also be fixed to look along a line parallel to the spin axis of Tiros II. However, here there is no alternate "look" into space. Its two collecting lenses are actually no more than thin plastic cones, coated with aluminium on one side, gold on the other. The "white" channel—white refers to the coating on the thermistor flake delicately poised on the thin strands of plastic fibre at the focal point of the lens—reflects visible light, but absorbs infra-red radiation. The "black" channel absorbs all radiation, infra-red and visible. The two values of radiation thus obtained permit scientists to calculate the Earth's albedo*. At the same time, the radiometer also measures the Earth's emitted radiation.

The complete construction of the 2-channel d.c. radiometer took place under a microscope. The plastic cones are only 2 mil (0·002 in.) thick. Furthermore, the platinum detector lead wires are only 0·0005 in. in diameter—about 1/10 the size of a human hair—and had to be wrapped around the thin strands of plastic fibre, finally soldered to 0·001 in. (dia.) wires.

*Albedo is the ratio of infra-red radiation reflected by the Earth, to the total solar radiation received by it. It is related to radiation efficiency.

Adaptive Control Systems

A summary of a discussion meeting held recently at the Institution of Electrical Engineers, on Adaptive Control Systems.

By L. A. STEINER, Ph.D.

THE history of any plant shows three main stages in its upward development. At the beginning, the most important requirement is that the plant works at all, i.e. that it produces something resembling the expected product. At this stage the plant is seldom properly instrumented.

As production commences in earnest, it is normally found that the product is not as uniform as it should be. Personal skill and supervision are now supplemented by alarm systems, instrumentation and automatic controls.

The next stage arrives with the question whether the output is, in quality, quantity, and financial return, the best obtainable. By now the plant is geared to a rigid schedule, not amenable to research and experiment and the financial return is buried in the files of the office.

Whatever the circumstances, the optimal operation of a plant is always a desirable objective.

Some of the ways and means how this desirable objective might be achieved were the subject of contributions by J. H. Westcott, J. L. Douce and P. H.

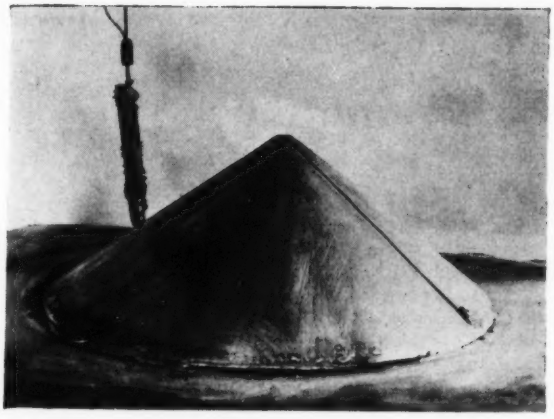


Fig. 1. *A hill-climbing experiment. The feeler moves around its temporary station and decides in which direction to go before it takes the next step.* (*Photo by Dr. Douce*)

Hammond at a recent evening at the Institute of Electrical Engineers, under the title " Self Adaptive Control Systems."

Basic Considerations

Let us first consider that the conditions under which a plant will yield maximum return in terms of cash will not necessarily be the same all the time. In a plant operated by automatic controllers of normal conception, the working conditions such as temperature, pressure, flow etc., will be kept at a constant, preset value in the hope that the quality of the product will also be constant. Alternatively, say in purity control, the quality of the product may be kept at the prescribed level by direct measurement. However, constant conditions are not necessarily the most economic and the desirable objective is often a matter of calculation in which quantity produced per day and the difference in price between sales price and cost price will enter. It will be seen that not all the necessary parameters can be measured on the plant itself.

The contemporary aim now is to develop systems (more than one) which will operate the plant not by adhering to a number of set points, but by a desirable index which will be calculated from the properties of the product and of the market. Such control systems should adjust the individual set points by themselves, i.e. without human action.

Accordingly, adaptive control systems must embody the customary means of sensing and controlling, plus means for judging which parameters and to what extent to adjust to obtain a desirable optimal result—as given by a performance index.

It is obvious that the birth of such systems will be accompanied by a lot of theory and some argument.

Variational Calculus, Hill-climbing and Correlation

The opening speaker, Dr. Westcott, treated the problem of optimum control as a multi-stage decision process using variational calculus in a form allowing a progressive solution to be developed. The method has particular interest as it is readily applicable to digital computer solution. This raises interesting questions of data handling techniques and coupling plant control to a digital computer for on-line operation.

Work of this type is still largely of a speculative nature and the best solution has yet to be evolved. It is likely that a satisfactory solution will involve the combination of variational and stochastic methods. Great interest attaches to the development for engineering purposes of stochastic methods since these will also open up the possibility of evaluating schemes of adaptive control.

Another aspect of the same problem was treated by Dr. Douce.

The performance index will be a function of, say, 3 variables and the bodily representation of the function will be a hill, irregular in shape, perhaps even with two peaks. However, due to the smooth variation of parameters of most manufacturing processes, the hill will not be as rugged as a natural mountain.

The problem now is, how to get to the top of the hill blindfolded.

Dr. Douce discussed a scheme for a self-optimising controller, i.e. a controller which will feel its way to the best value obtainable, and showed a film from which Fig. 1 was taken, in which a feeler starts at the bottom of the hill, moves in a circle around its temporary station before it decides to take a step upwards, moves round again, takes the next steps and repeats until the feeler arrives at the summit.

The fact that the feeler itself and the cone look primitive should not deter from appreciating the elegance of the method itself. Indeed, the audience duly acknowledged the arrival of the feeler at the top.

Mr. Hammond spoke of a more advanced type of exploratory control, which has two objectives: keeping the plant running at minimum deviation from any set point, and secondly, measuring the effect of disturbance which may appear at any time at an unpredictable location of the plant. To study the problem, an experimental analogue model of an adaptive control system is being used, i.e., a plant and its controller are simulated using standard analogue computer techniques. The experimental fluctuations applied to the setting of the controller are then correlated with the performance index and the output of the correlator is used to change controller setting in a direction which improves the performance index.

The speed of adaptation is, in practice, a matter of great importance and further development in the art of adaptive controls calls for an increase in the accuracy of measuring instruments so that the right decision can be taken at the earliest possible moment using as small steps as possible.

Other speakers mentioned the practical difficulty of putting a sinewave into a chemical process, the necessity of defining the precise meaning of the terms used and the possible application of self-optimising control gear which is commercially available.

Precision and Performance

THE development and manufacture of instruments for missile guidance and control places specialised demands on the factory where the work is carried out. These demands have been met in the new £1 M factory at Stevenage, recently completed for the British Aircraft Corporation, which houses the Instrument Wing of English Electric Aviation's Guided Weapons Division.

The Instrument Wing

This was first set-up by English Electric Aviation as part of a plan to build comprehensive facilities for the manufacture of complete guided weapons systems. At first, the Wing developed and produced relatively simple and large displacement and rate gyroscopes for Thunderbird, the British Army's ground-to-air missile. Later, when development of the Blue Water missile for the Army was ordered, it was necessary to take out a licence with the Minneapolis-Honeywell company of the U.S.A. for the manufacture and development of their seven-ounce miniature integrating gyroscope (the MIG). It has now been in production at Stevenage for two years and is the only miniature inertial quality gyroscope being made in Europe.

The starting of work on the MIGs coincided with the decision to expand the Instrument Wing into a factory with the most advanced and comprehensive facilities for this type of work in Europe. To do this the new factory had to be built, and the work now going on there is being done to new and very high standards. The production test equipment consists of measuring machines which are normally used only in standards rooms. At present about 40% of the output from the Instrument Wing is for Blue Water and Thunderbird, which are also both produced at Stevenage.

Development and manufacture of inertial quality instruments is not therefore the sole justification for the new Wing. It is capable of undertaking work on the widest basis which involves the study, evaluation and specification, not only of guidance systems, but also other systems using similar techniques.

Assembly

During the assembly of inertial quality instruments, the presence of particles of microscopic dimensions can materially influence their accuracy and reliability. Tolerances on many of the Wing's production components are expressed in millionths of an inch, and for this reason three grades of filtered air are fed to the assembly and evaluation areas of the Assembly Building. These are distributed to the various departments according to the nature of the work carried out. The air filtration grades are:

Super-clean	0·1—0·5 micron
Sub-assembly	2·0 microns
Assessment inspection	5·0—7 microns.

The temperature of these rooms is kept at 72°F and humidity between 35 and 45%.

Only staff actually working in the Instrument Wing are normally allowed inside. They have to go through changing rooms to put on special smocks and caps. In the super-clean areas where final assembly is done, the staff make a further change into overall suits and anti-static boots. Over and above all these precautions, the actual instrument assembly is done under special cabinets where super-clean air is continually pumped over the assemblers' hands to prevent dust particles from settling on the work. Because the instruments are extremely sensitive, special precautions have to be taken to ensure that they are isolated from all vibrations when under test.

The Assembly Building contains no dynamic machinery, the air-conditioning plant itself is sited 80 feet away from the building and all connections for air filtration, temperature and humidity control are by flexible overhead ducts. Single storey construction minimises wind disturbance and elaborate additional precautions have been taken to isolate instruments under test from all sources of vibration. The instruments are tested on plinths projecting through the suspended floor from 50 ton concrete blocks in the basement. These blocks can be converted into mechanical vibration filters by supporting them on rubber cushions filled with air.

Assessment of Performance

Assessment of instrument performance in a practical system demands closely controlled laboratory conditions. For assessment of ultimate performance, special gear has been designed and elaborate precautions are taken to ensure that performance is not influenced by outside factors. These basic tests give true instrument performance. In a practical system, certain degeneration of performance can be expected due to environmental conditions and these also have to be simulated in the laboratory.

Some of the equipment has been designed by the Wing to enable instrument performance to be assessed. The accuracy of such assessments has of course to be of one order better than the specification of the instrument demands.

Among the assessment facilities is a precision centrifuge designed to test accelerometers under preselected conditions of acceleration.

To achieve uniform acceleration, all possible sources of disturbances are reduced to a minimum.

The assembly carrying the instruments under test

rotates on a central air bearing above a precision ground granite slab. Driving torque is provided by tangentially mounted air-jets, so eliminating the friction inherent in mechanical drives.

The centrifuge rotates at speeds up to 120 rev/min. The speed is measured by gating 5 Mc/s pulses, and counting appropriate intervals. Accuracy to 3 parts in 10^6 is achieved.

The change in radius of the centrifuge is continuously monitored by a differential capacitance bridge balancing technique, ± 10 micro-inches being the accuracy achieved.

The data is stored and printed out once every three revolutions. The test device is made available for use by research establishments and other firms.

A linear acceleration device the "bouncer" has been developed for testing gyros and accelerometers.

Its operation is based on the assumption that in certain conditions, short pulses of high acceleration alternating with periods of free-fall can be considered as equivalent to one pulse of longer duration at the same high acceleration.

The instrument under test is loaded into a carrier, which is guided by granite pillars and uses stiff air-bearings as guide shoes. The carrier is allowed to drop onto an actuator, which slows, stops, and then accelerates the carrier to the same speed in the reverse direction. The actuator, therefore, imparts a pre-selected acceleration, the carrier rises to the top of its stroke, and the cycle is repeated.

The maximum weight of test instrument is up to 30 lb and accelerations up to 15 *g* can be obtained. The linearity is ± 0·1%.

Systems Produced

The miniature integrating gyroscope GG.49 is manufactured under licence from Minneapolis-Honeywell and is one of a series of high performance instruments specifically designed to use in short term inertial systems, central stabilised reference platforms and similar applications. The gyro is an advanced example of the single axis floated rate integrating principle, in which the gimbal is floated at neutral buoyancy, thus eliminating weight on the pivots and reducing pivot friction.

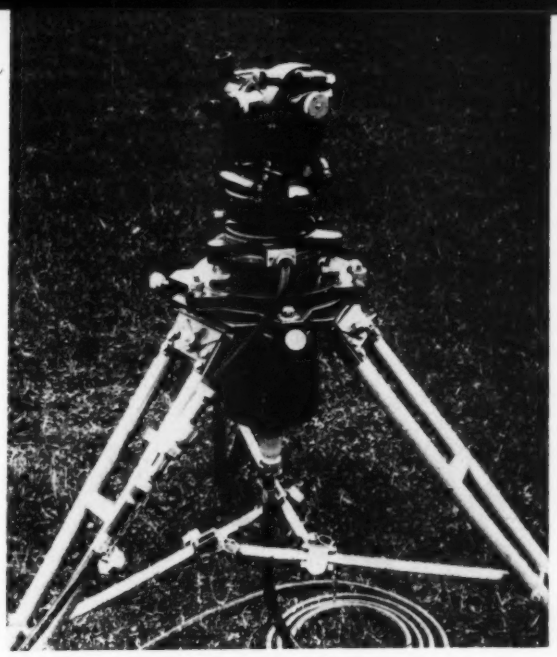
Its performance is such that variation after warm-up is 0·05°/h maximum drift and variation due to environmental cycling is ± 1°/h maximum drift. The operating temperature is 82°C.

One of the systems designed by the Instrument Wing using inertial components is the precision indicator of meridian (PIM).

Accurate determination of true north without visual reference is required for gun laying and pre-flight alignment of missiles and aircraft. PIM exploits the sensitivity of a rate integrating gyroscope to detect the east west line about which the component of the earth's rotation is zero.

North can be detected within 1 minute of arc. The sensitivity of the gyroscope used in PIM is such that it can detect a turning rate equivalent to one rotation of the earth in 20 years.

Interest has also been shown in the PIM system for survey in mines and tunnels where normal visual and astronomical methods are not practicable.



Precision indicator of meridian (PIM)

Production Test Equipment

In addition to the development of advanced production techniques essential in the manufacture of high performance instruments, it has also been necessary to design and develop a wide range of specialised production test equipment. One item is the IFG 106 floated gyroscope test equipment. This is capable of carrying out a full range of tests on a rate integrating gyroscope. It is now in production by the Instrument Wing and has been sold to users of MIG gyroscopes, and is being marketed for the users of rate integrating gyroscopes.

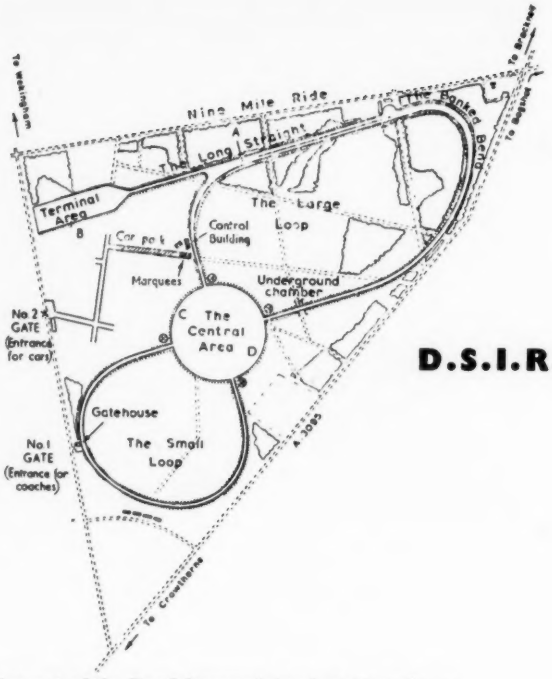
Typical tests which may be performed are: measurement of gimbal-stop and null-signal voltages; various open-loop drift tests; gimbal to case continuity; determination of error torques; null repeatability; determination of gyro transfer function. The English Electric direct reading permeammeter IFG 108 has been designed specifically as a quality control instrument for obtaining instantaneous readings of the permeability of samples of magnetic material and small components, such as torque motors and signal generators, stators and rotors. Such checks are necessary in the case of high permeability materials used for the laminations of precision spin motors, pick-offs etc.

The permeammeter provides pre-selective flux levels, automatic de-magnetisation of the sample and accuracy of 5% full scale. It is self contained in a 4 ft 4 in. console and is being produced in small quantities for the commercial market.

Guided weapons development has provided the impetus for advances in many branches of engineering, and the techniques used in the production of the infinitely accurate gyroscopes and other guidance equipment are being adopted in the development of equipment for the mines, surveying, the steel and electrical industries, long-range pinpoint navigation by sea, air and in space, and the expanding field of electronic computers.

Open Days at

D.S.I.R. Road Research Laboratory



Layout of the Road Research track at Crowthorne

D.S.I.R.'s Road Research track at Crowthorne, Berks, first came into service last October and since then a number of experiments have been carried out using the new facilities. At the Open Days held recently demonstrations and exhibits showed the latest research work on skidding, shattered windscreens, legibility of motorway signs, on the spot investigation of accidents, control of traffic lights on high speed roads, automatic detection of congestion and electronic guidance of vehicles.

The Research Track

The Research track contains a number of different test sections and varying types of road surfaces. There is also a special length designed so that speeds up to 100 m.p.h. can be reached.

The high speed section, which is approached by a banked bend, is covered with typical road surfacings which can be kept wet by means of a built-in system, fed from a large supply tank. This permits skidding and braking studies to be made. Tests such as these are becoming more and more necessary as a means of investigating the characteristics of road surfaces and tyres to reduce as much as possible the risk of skidding on wet surfaces at high speeds.

This is backed up by work at the Harmondsworth Laboratory on evaluating road surface materials for resistance to skid, wear, and temperature effects.

Beneath another section there is a laboratory with a glass panel let into the surface of the track enabling contact areas of tyres to be photographed as vehicles are driven over it. This enables the behaviour of tyres at the critical points of contact with the road surface to be studied.

"On the Spot" Investigation of Accidents

The Road Research Laboratory has found by experience that studying road accidents on the basis of police reports did not enable them to find out the causes of accidents. The only way of doing this was to make a study of the scene of the accident.

For four years now the Road Research Laboratory has had an arrangement with neighbouring police forces which has enabled a special investigation team to attend accidents within a radius of 8 miles.

The specially equipped vehicle which the team uses has a pneumatically operated mast which can be hoisted high above the scene of an accident to take photographs.

Over five hundred accidents have been studied in this way. Important data have been obtained on injuries to the occupants (e.g. the frequency of head-windscreen impact rather than head-fascia board impact and the more injurious effect of laminated glass as compared with toughened glass) the frequency of vehicle defects and on the effect of lamp standards, trees and sign posts.

Traffic Lights on High Speed Roads

If traffic lights are used on high speed roads, the timing of the changes from amber and red are of the utmost importance. Depending on the speed of the approaching vehicle, there is a zone before the lights and if the lights change while the vehicle is in this zone, it will neither be able to pull up in time before the lights, nor to pass through the lights before they change to red.

The detecting of approaching vehicles and sensing of their speeds so that lights may be operated on the basis of this information, is one of the studies which is being undertaken by the laboratory.

Detection of Congestion

Vehicle presence detectors have many applications and among those being investigated by the Laboratory are the detection of long queues of traffic, illegal parking in critical places and congestion in a roundabout. Detectors have been developed which can

distinguish between fast moving traffic indicating good traffic flow and slow (congested) and stationary traffic.

The equipment could be used at a signal-controlled roundabout to indicate imminent "locking-up", so that the inflow of vehicles to the roundabout could be temporarily stopped to allow the traffic to clear.

A further possible application of these detectors is to feed the output indicating whether roads are congested or not to a computer. Anyone wishing to make a journey could then get the best route from the computer based on the conditions, at that time, of the roads.

Use of Guidance Cables

The track has been provided with means for experiments on the guidance and control of vehicles*. Wires laid below the surface of the track will emit signals which can be detected by electronic devices on the vehicles. This system could be used to warn vehicles of other vehicles ahead, or to check the speed of passing vehicles and warn drivers when they exceed the limit.

Signals from the guide wire could be linked direct to the car controls and the car driven automatically. In conditions of bad visibility this could have definite advantages.

*Electronic Means for Lessening Traffic Accidents. *Instrum. Pract.*, Nov., 1959, pp. 1146-1148.

A demonstration of the electronic guidance of vehicles. The sensors which pick up signals from a wire laid below the surface of the track, can be seen attached below the front bumper of the car

The work on electronic guidance of vehicles does not, the Laboratory says, form a major part of its research programme. Over the last few years a considerable amount of work has been undertaken in the United States on this subject, and according to the Laboratories there is some exchange of information.

NEW PATENTS

The following extracts have been taken from specifications obtained from the Patent Office, and permission to publish has been given by H.M. Stationery Office. The Official Journal *Patents* can be obtained from the Patent Office, 25 Southampton Buildings, London, W.C.2.

Patent No. 836,195. Optical Distance Measuring Devices.

Associated Electrical Industries Ltd. (*Inventor: James Dyson.*) (*Application No.* 7175/56.)

In an optical range finder used to determine the distance of an object from an observer where direct measurement is impossible, the principle of operation is to measure the angle between one of two lines of sight which are adjusted to intersect at the object, and a base line of known length. The range is determined from a knowledge of the length of the base line and the tangent of the measured angle. In some cases the reflection of light from the surface of the object is insufficient to enable accurate images to be obtained along the two lines of sight so that they may be optically superimposed by adjustment of the lines of sight. In this invention improvements have been developed of methods already employed to overcome this difficulty.

Patent No. 837,002. Temperature Control Systems.

Robertshaw-Fulton Controls Co. (*U.S.A.*) (*Application No.* 20605/56.)

The invention relates to heat control systems wherein the heating medium consists of a slurry of fusible material having a melting temperature equal to the desired temperature of a container whose heating is to be controlled. The invention comprises: the container for housing the fusible material forming the heating medium, this material has an electrical resistance in the slurry state which varies according to the solid-liquid ratio; electrical heating means for forming and maintaining a slurry of the material; and means, responsive to changes in the electrical resistance of the slurry, for increasing or decreasing the heat output as a continuous function of the change of the slurry's solid-liquid ratio. By these means the material is kept in the slurry state and the temperature is maintained approximately constant. Various metals and alloys are suitable for use as the fusible materials and a list of these, showing the temperature at which each will fuse when heated to a prescribed melting temperature, is given in the specification.

Patent No. 837,419. Electrolytic Condensers.

The Plessey Co. Ltd. (*Inventor: Harold Ffyner Collender.*) (*Application No.* 3011/56.)

The main object of this invention is to provide improved electrolytic condensers of the kind described in British Patent Specification No. 675,353. In these condensers a sintered tantalum body is secured to a non-porous tantalum plate and suspended in an electrolyte such as sulphuric acid. The container is formed by the tantalum plate with a cup-shaped cathode of silver, a sealing member made of a suitable electrically insulating material being interposed.

The main object of the invention is to provide an electrolytic condenser wherein the cathode surface area is increased by sintered particles of the cathode material.

SIMA Notes

SIMA Export Forum

As noted last month the first meeting of the SIMA Export Forum was held on the 2nd May.

The meeting was an unqualified success. The emphasis was on practical assistance as opposed to exhortations and speeches. A representative of the Board of Trade who attended as an observer stated that in his opinion it was one of the best and most fruitful meetings of this type which he had been at.

Member's comments and requests for further meetings have already been received in large numbers and the intention is to have a series of meetings, possibly quarterly, to discuss points raised by members and also other ways of assisting the export drive.

Enquiry Service

The report on the third year of operation of the Enquiry Service has now been received and shows a most satisfactory expansion. Just under 4,000 enquiries were received and dealt with during the year April, 1960 to March, 1961, and in 95% of the enquiries the Service were able to give a full and satisfactory answer and to recommend a suitable supplier for the type of equipment required. In the majority of cases where answers could not be given, the enquiries dealt with addresses, trade names, agents, etc.

A satisfactory trend was noted in the enquiries from overseas which now represent approximately 30% of the total, and have risen by 6%, including enquiries from a number of new areas, amongst others, the U.S.S.R. This is probably a result of the SIMA Exhibition in Moscow in 1960.

In view of the initiation of the SIMA Direct Mail Campaign it is hoped that this very satisfactory expansion of the Enquiry Service will be further extended.

Direct Mail Campaign

A new publicity venture has now been initiated and during the forthcoming year some 150,000 prestige leaflets publicising the SIMA Enquiry Service will be disseminated throughout both the home and overseas markets. This effort has been made possible by the generosity of members who have agreed to distribute the Association's Direct Mail material with their own Direct Mail advertising, in certain selected markets where the greatest impact seems desirable.

15th Annual Dinner Dance

The 15th Annual Dinner Dance was held at the Dorchester on 14th April; some 600 people attended which was a new record. Rear Admiral Roy Foster Brown, C.B. replied to the President's toast " Our Guests " and then entertained all present with one of his usual amusing and excellent speeches. In all, a most enjoyable function which had been very well organised by the Dance Committee under the Chairmanship of Major W. Logan, of Avo Ltd.

Activities of the Northern Area Group

The Northern Area Group now consists of some thirty-three members who hold quarterly meetings under the Chairmanship of Mr. A. W. Burrell, of Cambridge Instruments Ltd.

The Group is particularly active. The aim is to keep members in the North acquainted with the activities of the Association and to ensure that the views of members outside the London area are adequately represented. At the same time the expansion of the membership and the publicising of SIMA activities amongst customers of member firms, is a feature of the efforts of the Group.

The Group recently participated in the Royal Institute of Chemistry Exhibition in Manchester, and ran a SIMA " Information Stand " which was of some considerable interest to visitors.

Annual Golf Match

The SIMA Annual Golf Match took place at Highgate Golf Club on Friday, 5th May and proved a most enjoyable event. Some fifty members and guests were present and the results of the tournament were as follows:

Pullin Cup for visitors:	Mr. J. Hayman (guest of G. H. Zeal Ltd.).
SIMA Cup for members:	Mr. M. Zeal of G. H. Zeal Ltd.).
Aldis & Watts Cups:	Mr. C. Wells and Mr. A. H. Campbell of Electronic Instruments Ltd.

Standardisation in the Field of Ultrasonics

The Executive Committee has now held its first meeting and a number of Sub-committees have been appointed with their full terms of reference. Considerable interest has been shown by all concerned including non-member firms who are involved in the field.

Further meetings will be held throughout the year and it is hoped that interim reports will be ready before the end of the year.

Apprenticeship Certificates

The apprenticeship certificates of the following member firms were endorsed by the official seal of the Association indicating that a course of instruction approved by the Association had been carried out.

Baird & Tatlock Ltd.	1
Wray (Optical Works) Ltd.	1
Hilger & Watts Ltd.	3
Edwards High Vacuum Ltd.	8
R. B. Pullin & Co. Ltd.	2
The Precision Tool & Instrument Co. Ltd. ...	1

Speed control of Electric Motors

'Variable' speed may involve two or three (or more) speed steps or infinitely variable (stepless) speed control. It is this latter type which is considered below. Of the many advantages of electric drives, the opportunity offered for infinitely variable speed control is outstanding. Unfortunately this advantage is not used as much as it might be to increase the speed of working, and to improve productivity and quality.

Principal Factors Affecting Choice of Drive

(a) First cost, (b) Efficiency, (c) Speed range, (d) Regulation, (e) Power-to-weight ratio, (f) Availability of supply, (g) Maintenance and reliability, (h) Change in power and torque over the speed range, (i) Simplicity of control gear, (j) Effect of variation in supply, (k) Power factor, (l) Characteristics of the load, (m) Operational environment, (n) Braking requirements.

This list is not meant to be all-embracing, for there well may be factors not mentioned which could prove conclusive in the choice of a drive.

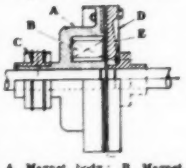
The following are some methods of obtaining infinitely variable speeds:

Alternating Current Motors

The vast majority of electric drives in use today employ A.C. motors. Although not quite so flexible as D.C. motors in the matter of speed control, there are available many types which give a large measure of speed variation.

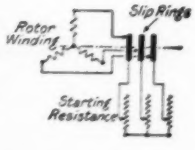
INDUCTION MOTORS. Although the squirrel-cage motor is essentially a constant-speed machine, it is much used for stepless variable speed drives with one of the following types:

(a) Eddy-current coupling,
(b) Ferro-magnetic particle coupling,
(c) Mechanical drives, e.g. belt drives and friction drives,
(d) Hydraulic variable speed drives.



A, Magnet body; B, Magnet coil; C, Collector gear; D, Spring plate; E, Armature.

SLIP-RING MOTOR. The slip-ring motor, which costs more than the squirrel-cage motor, can be varied in speed by means of the resistors in the rotor circuit used for starting. The amount of resistance in circuit can be varied in steps by means of different forms of control gear operated by hand, push-button or automatically controlled contactors.



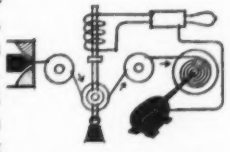
A.C. COMMUTATOR MOTORS. These are three-phase induction motors provided with additional windings which, through a commutator and brushes, permit speed adjustment in either direction below and above synchronous speed. The brush gear can be automatically controlled so as to vary the speed according to a known programme or cycle of operation such as in spinning frames. The Schrage and similar motors are refinements of this type.

Ward-Leonard System

In this system the armature of a D.C. motor is supplied at variable voltage from a separate generator. The generator may be driven by an A.C. or D.C. motor directly coupled to it and to an exciter which supplies the field windings of the generator and main motor. By means of a potentiometer resistance, with mid-point connected to one terminal of the generator field windings, the generator voltage may be varied from maximum to zero.

Electronic Motor Control

Motor speeds can be controlled accurately by electronic methods. Such drives can respond in any desired manner to variations in one or more variables and several drives can be interlocked so that their speeds are always in the same ratio. A typical application is on several separate conveyors. The system can be speeded up or slowed down from a 'master' controller, but for 'running in' purposes the speed of each drive can be individually regulated. Electronic speed control has been successfully applied where human control is not possible, e.g. in register control. In this example print must always be placed at exact positions on packaging material. The sketch shows electronic control of wire tension in drawing operations.



Direct Current Motors

While it is unlikely that a mains supply of D.C. will be available, the striking advantages of D.C. motors sometimes make it worth while installing a rectifier, e.g. a motor-generator set, a mercury-arc or a semi-conductor. The speed of D.C. motors is easily controlled by inserting a resistance in series with the motor. Although this can result in a certain amount of wasted electricity, the benefits derived will often heavily outweigh such losses.

For further information get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London, W.C.2. Telephone: TEMple Bar 9434.

Excellent reference books on electricity and productivity (8/6 each, or 9/- post free) are available —'Electric Motors and Controls' is an example.

E.D.A. also have available on free loan in the United Kingdom a series of films on the industrial uses of electricity. Ask for a catalogue.

Circle **358** for further information

BECKMAN INSTRUMENTS LIMITED

GLENROTHES, FIFE, SCOTLAND

HELIPOT PRECISION MULTI-TURN POTENTIOMETERS

DUODIAL TURNS— COUNTING DIALS

MODEL D2 PORTABLE OXYGEN ANALYSERS

ZEROMATIC pH METERS

BECKMAN pH ELECTRODES

GAS CHROMATOGRAPHS

SPECTROPHOTOMETERS

EPUT DIGITAL COUNTERS

BECKMAN, HELIPOT, DUODIAL, ZEROMATIC, and EPUT are the registered Trade Names of Beckman Instruments Limited

(3701)

SURVEY OF NEW INSTRUMENTS

ELECTRICAL · ELECTRONIC · MECHANICAL · NUCLEONIC · PNEUMATIC

Miniature Crystal Phosphor

A RECENT addition to the Hilger & Watts range of crystal phosphors is a miniature thallium-activated sodium iodide crystal mounted in magnesium oxide in a glass-windowed canister only $\frac{5}{8}$ in. in diameter. Its standard resolution is between 8% and 10%.

The crystal is suitable for thin probes. Several crystals can be arranged in a mosaic to give resolution over a large area, for which purpose a single crystal would be difficult to grow and very expensive.

Circle **1** *for further details.*

Subminiature Transistor Holders

PURE p.t.f.e. is used in a new range of transistor holders which utilises the Sealectro "Press-fit terminal" technique of fixing. A hole is drilled or punched in the chassis and the transistor holder is then pressed into position with a simple tool, when it becomes firmly fixed in position.

The p.t.f.e. body is machined to tightly-held precision limits which do not vary in production and is almost completely damage-proof.

Subminiature valve-holders, too, are available. Pins of 0·010 in. and 0·24 in. diameter can be accommodated without effect on contact or retention efficiencies. Contacts are of gold-plated beryllium-copper and the pin sockets are formed from a rectangular channel section giving maximum contact area.

Circle **2** *for further details.*

Transistor Power Supply

THE transistor power supply from Startronic Ltd. has a twin supply, 0–20 volts each section, variable by decade switching in 100 mV steps. Maximum output current is 0·5 amp and the two sections may be operated completely independently, or series connected to give 40 volts at 0·5 amp, or paraliel connected to give 20 volts at 1 amp.

The regulation is better than 0·1% zero to full load and the stability factor is better than 1500 : 1. Ripple is less than 1 mV r.m.s.

This unit is particularly suitable for pulse loading and great care has been taken in design to avoid switching transients and all other causes of high voltages appearing across the output terminals which could damage any circuit connected to the power supply.

A maximum current limit switch is incorporated which enables the maximum current obtainable from the supply to be set to values as low as 10 mA. This protects the external circuit as well as the supply itself in cases of accidental overload. The unit is completely protected against overloads and may be left in an overloaded or short-circuited condition indefinitely with no fear of damage occurring.

The system of overload protection used is entirely electronic and resets instantly when the overload is removed. A red lamp lights when the maximum current limit is exceeded and any further overload will cause the current through the load to decrease. These features enable the unit to be used in applications where heavy switch-on load surges are experienced, for instance, highly capacitive loads and series motors.

Because of the overload protection characteristics of this power supply it is particularly recommended for experimental transistor work where mistakes can prove expensive and as it is virtually indestructible it is particularly suited to educational establishments.

The price of the twin supply is £99 0s. 0d.

Circle **3** *for further details.*

Portable or Static Blending Machine

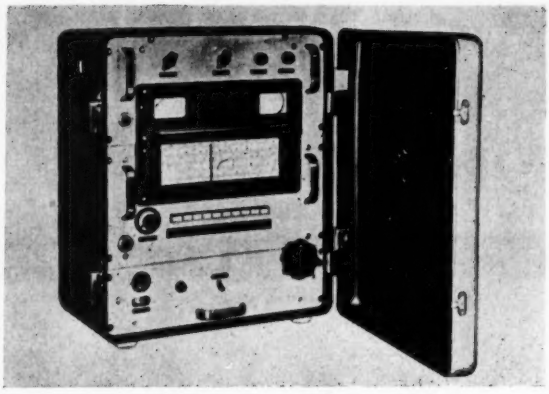
BY standardising the mechanism a new blending machine, which can be incorporated in a portable or wall-mounted unit, has been produced by Suba Hydraulics Ltd.

This unit will bring any two liquids together and deliver in a pre-arranged proportion through a diffuser chamber just prior to delivery. The settling out problems usually associated with storage vessels are thus eliminated.

By using one liquid under pressure as a constant factor the second liquid can be added to give a proportion from 5% to 40% of the total output.

All liquid-handling cylinders are in brass; end castings, pistons and valves are in bronze and the pipes and fittings are copper and galvanised steel. The tanks and cover are mild steel, all welded. The inside of the tank is treated with alcohol-resisting dressing and the outside of the tank and non-moving parts are finished hammer blue, with hoses in clear vision braided nylon.

Circle **4** *for further details.*



Kretz E-G meter

Measuring Moduli of Elasticity in Solid Materials

A NEW aid to quality-determination in structural materials has been introduced into the U.K. by Aveley Electric Ltd.

The E-G meter manufactured by Kretz allows rapid and repeatable measurements of the dynamic modulus of elasticity (E) and the torsional modulus (G) of solids such as metal, concrete, rock, plastics, wood, coal, ceramics and other rigid materials.

The instrument gives repeatable measurements within 0·5%.

The dials are directly calibrated in ton/cm² and lb/in². The provision for the use of five calibration units and push-button selection of ranges greatly speeds up the testing of a large number of samples.

The 10 in. long slide-rule dial carries a calibrated scale for the common materials, and extra scales for special material. Accuracy of the instrument is guaranteed by a built-in quartz-crystal controlled oscillator, providing check points on the dial.

The equipment is reliable and self-calibrating and is equipped with a pulse-transmitting test-probe and a mounted adjustable receiving probe to ensure accurate application to the test sample.

Construction of the instrument is robust and it is suitable for portable use.

Circle **5** *for further details.*

Pipeline Control by Telemetry

PIPELINE remote control equipment is being offered by Rotax Ltd. as a result of an arrangement with the Southwestern Industrial Electronics division of Dresser Electronics, U.S.A. This equipment has been manufactured and supplied for several years to major companies in the American oil, gas and chemical industries. The system offered is well tried and has built up a considerable reputation for reliability under actual working conditions.

This solid-state, printed-wiring equipment can give remote control by radio or land-line pair of pumps and valves, etc., at a number of unmanned stations. This is assisted by the central display and printer logging of alarms and variables such as pressures and flows, etc., measured by instruments at the stations. As two finished systems are very seldom alike, the equipment design is adaptable to meet a range of requirements. Individual systems also can be extended easily to provide extra facilities if additions are made to plant and/or instrumentation at a later date. Rapid servicing by non-technical personnel is made possible by a simple circuit substitution method using standard circuit cards.

Circle **6** *for further details.*

Industrial Electronic Weighing

A NEW range of electronic weighing equipment is being introduced into Great Britain by Rotax Ltd., under a licence agreement with the leading manufacturer of this type of equipment in the U.S.A. A full engineering service is provided to cover design and installation of complete systems, including instrumentation and associated steel structures.

Weight indication can be given on a visual dial indicator, a full numerical digit indicator or digital display. Weight recording can be given using a pen recorder or made digitally, with print-out on a ticket or tape. Combinations of these can be supplied if required and equipment can also be provided to drive teletype and punch card accounting equipment.

Provision can be made to integrate the system into process control schemes. It is particularly adaptable for use in batch weighing, tank and hopper weighing, crane weighing and weighbridge systems. It is robust and able to operate under severe conditions.

Circle **7** *for further details.*

Elmeg Print-out Assemblies

TELEPHONE MANUFACTURING CO. LTD. Elmeg print-out unit assemblies to deal with complex recording problems have now been added to their range of Elmeg counters.

The assemblies will record the results from many separate electrical impulse sources in one operation. The largest of the four assemblies now available accommodates a maximum of twelve 5-digit print-out counters or a total of 36 single decade counters—all resettable.

Suitable for either panel or rack mounting, the assemblies provide a permanent record of weights, dates, sizes, quantities, temperature and speeds—in fact, any measurement that can be passed to the equipment as an electrical impulse.

Circle **8** *for further details.*

Capacitors

THE Standard Telephones & Cables Ltd. range of oil-impregnated oil-filled paper capacitors in the split-case tubular construction with silvered ceramic seals has found a wide range of application in electronic equipment where high reliability is required at temperatures up to 70°C. A special construction has been adopted to reduce the vulnerability to leakage to which such designs are usually prone when used in high temperatures or in conditions of severe vibration. At the same time the new range, coded 453 LWA 270-282, retains all the advantages of the earlier types.

Circle **9** *for further details.*

Automatic Test Equipment

THE Autotest Division of Elliott Bros. (London) Ltd. now have available automatic test equipment in sub-unit form.

The SCORE units have been designed so that manufacturers may purchase their equipment in unit form, and expand their automatic test system gradually. The resulting system, devised for the particular job in hand, will, depending upon its complexity, provide the basis for a general purpose system with the addition of further sub-units.

SCORE—1. *Switching Unit*

This unit forms the nucleus of the equipment and is capable of performing a continuity (i.e., connection or no connection) test on up to 200 outlets. A comprehensive pre-set continuity checking unit is also available, which enables a specific continuity resistance to be catered for. Any increase on this pre-set value will automatically register a fault. A numerical display on the front panel will indicate on which line the fault has occurred, and as an optional extra, print this number on a paper roll. If no printer is used, an operator should note the number and re-start the equipment.

To double the capacity a second continuity checker may be added to increase the number of outlets to 400 or, to arrange for random testing between any two lines. (This combination would probably be used initially in conjunction with the insulation checker.)

SCORE—2. *Insulation Checker*

This unit will test the insulation resistance of the line—either to earth or to any (or all) other lines. If the insulation resistance is less than 50 megohms a similar indication will be displayed to that given by the continuity checker. Where called for the test voltage may be applied for the length of time specified for insulation checks—disregarding the normal test time of 1/10 second.

Thus with these first two units a complete insulation and continuity test schedule may be accommodated for up to 400 lines.

SCORE—3. *Resistance Unit*

Resistances in the range of 1 ohm—1 megohm may be checked with this unit. However, as these resistances are unlikely to be similar on every line a programme is necessary, to dictate to the equipment what condition it must look for. This means that the programme must contain the following relevant information:

(a) Value of resistance
(b) Tolerance acceptable
(c) Circuit numbers.

Tolerance ranges at present available are 1—20%.

SCORE—4. *Programmer*

For simple continuity or insulation tests, a test schedule programme may be set up on a patchboard enabling the equipment to select the test requirements at the appropriate time.

Whilst this patchboard is perfectly satisfactory for setting up a few tests of each type, it is uneconomical to programme a large random selection of tests. To overcome this, a magnetic tape programmer is available which has many advantages.

Primarily the tape system will enable tests to be set up in any order, thus allowing freedom of flexibility. Also, quantities of similar tests (e.g., insulation) may be introduced, with no waste of programme tape, by pre-determining the number of similar tests to be applied.

Another feature is that test programmes may be modified, in sympathy with modifications in the test specification, by the simple expedient of re-writing on the tape (at the particular test position) the revised information.

A writing unit is incorporated with press-button types of keys for use in conjunction with the magnetic tape programmer.

SCORE—5. *Capacitance and Inductance Checker*

This unit will allow capacitances (from 1,000 pF—1,000 mF) to be checked—along with inductances in the range of 10 mH—100 H. At this stage only the effective impedance will be checked, no leakage tests being applied.

Circle **10** *for further details.*

Conveyor for Bulk Powder

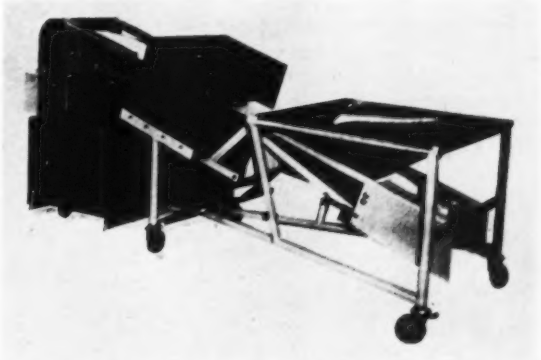
THE need for a convenient method of inspecting bulk powdered material for tramp metal has increased recently due to the trend of introducing continuous flow production lines.

Automa Engineering Ltd. have designed a light duty conveyor to work in conjunction with the LOMA metal detector which they also manufacture.

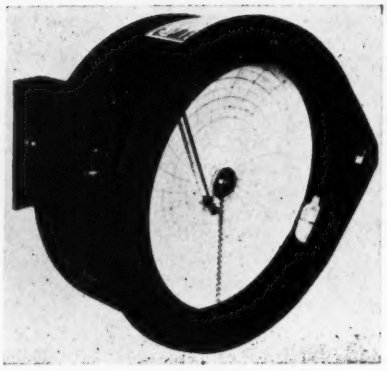
The photograph shows a feed hopper which is situated such that it can be easily fed by hand or machine. The product is conveyed by a troughed food quality rubber belt through the metal detector and on to the next process. On the detection of metal a signal is stored until the product reaches the end of the conveyor when an automatic rejection chute operates and diverts the contaminated material into a reject container.

The conveyor is of tubular construction and has a stoved enamel finish. Castors are provided so that the whole unit is portable. Variable speed drives can be fitted if required as an extra.

Circle **11** *for further details.*



Portable light-duty metal detector conveyor for use with powdered materials



Arkon Model 60 pressure recorder

Solenoid valve

Pressure Recorder

ARKON Model 60 pressure recorder, manufactured by Walker Crosweller, is now available for wall mounting.

Of sturdy construction, the recorder is driven either by a spring wound clock or electric motor.

The instrument uses an 8 in. diameter chart having 24 hours or 7-day rotation. It is available for a wide variety of ranges from 5 lb/in² to 500 lb/in² and is suitable for the measurement of gas, air, steam, water, oil and similar liquids.

The recorder has a dust and moisture proof glazed door, fitted with an integral lock, and the chart record is visible at all times.

There is also a portable version available which is fitted with handle and stand; its total weight being only 9½ lb.

Circle **12** *for further details.*

Mesa Transistors

THE transistors AFY 10 and 11 AFY are germanium p-n-p mesa transistors. They are particularly useful for oscillators, transmitters and low-noise amplifiers at high frequencies as well as for broad-band amplifiers.

Maximum ratings:

Collector voltage	$-V_{CE}$	= max. 15 V
Collector voltage	$-V_{CB}$	= max. 30 V
Emitter voltage	$-V_{EB}$	= max. 1 V
Collector current	$-I_C$	= max. 70 mA
Junction temperature	T_j	= max. 90°C
Dissipation at 45°C ambient temperature	$Q_{(C+E)}$	= 180 mW
Dissipation at 45°C case temperature	$Q_{(C+E)}$	= 500 mW
Thermal resistance between junction and ambient static air	R_{th}	= 0·2°C/mW (<0·25)
Thermal resistance between junction and case	R_{th}	= 0·05°C/mW (<0·09)

These Siemens transistors are obtainable through R. H. Cole (Overseas) Ltd.

Circle **13** *for further details.*

Solenoid Valve

THE K.10 magnetic lever valve, manufactured by General Controls Co., is now available in the United Kingdom in sizes from 0·063 port size. It is capable of flow media temperatures of up to 360°F and pressures up to 1,000 lb/in². Body materials are available to suit all media including corrosive fluids.

The electrical system is 2 wire control with replaceable coil. The jacket rotates 360° for easy installation.

Circle **14** *for further details.*

Electronic Gas Detector

THE I.E.C.-Sieger detector head instantly signals the presence of a concentration of inflammable gas to a dual warning system which automatically gives an audible and visible alarm.

In this instrument, catalysts are impregnated in an insulating material which is heated by a wire coil, part of a balanced circuit. Similar insulating material and coils form, with the detector lead, the other arm of the circuit. Wires so supported resist vibration, accidental damage and burn-out.

These catalysts react to inflammable gas by increasing the temperature and electrical resistance of the coils thereby unbalancing the bridge. Ambient temperature changes affect both wires equally and the circuit remains balanced.

Electrical unbalance caused by a gas is amplified by a transistor in a special feed-back circuit which operates a relay and the dual alarm system. Because several catalysts are combined in the I.E.C.-Sieger detector it is sensitive to all inflammable gases and consumes less than ½ A. Concentrations of gas are less likely to fuse the wire as occurs with platinum.

The dual alarm system is reliable and foolproof. The green indicator lamp is connected in series with the detector circuits and will not light up if these are broken. The signal lamps have a normal life of 1,000 hours but the green lamp is under-run by 20% and its actual life is much longer. Electrical contacts, housed in the spray and corrosion-proof control box, are protected from the effects of continued use in corrosive atmosphere.

The detector head of corrosion resistant alloy is suitable for ambient temperatures up to 300°F (approx. 150°C). Three layers of stainless steel Monel flameproof

gauze enclose the sensitive elements, preventing flash-back. Cable connections to the head are sealed against corrosion by "Araldite". Its sensitivity is unaffected by pressure changes.

The Mark 7 model is provided with a high-speed sealed relay. The contacts of this relay are rated for currents up to, but not exceeding 0·5 A. This is adequate for the operation of a bell, relay, contactor, or magnetic shut-off valves, etc.

The connections are brought out to a terminal block so that an external relay can be fitted for the operation of local or remote warning devices. Two terminals are also fitted to enable a meter to be used to determine the value of gas concentrations.

A precision potentiometer permits the sensitivity of the detector to be accurately set at predetermined points between the detector's normal threshold of sensitivity and the lower explosive limit of the gas to be detected.

Means for locking the potentiometer setting can be provided, if specified with order.

Special temperature compensation circuits are used so that the unit can be employed in conditions where the ambient temperature may range from 14°F (−10°C) to 113°F (45°C).

Circle **15** *for further details.*

Transistor Vibration Meter

THE transistor vibration meter, Type 1431, from Dawe Instruments Ltd. is a compact and portable transistor instrument designed to measure the three important characteristics of vibration: displacement, velocity and acceleration.

For use in field conditions this instrument will operate from an internal battery power supply thus facilitating vibration investigations in such places as aircraft, ships, motor vehicles, etc., where no mains power supply is available. The instrument can also be used with the standard mains power supplies.

The transistor vibration meter, Type 1431, comprises a vibration pick-up, a high gain amplifier incorporating integrating and differentiating networks and an adjustable attenuator, together with a direct reading indicating meter. The Type 1403/1 vibration pick-up supplied is of the moving coil type and gives an output proportional to the velocity of the motion under investigation. This voltage is fed into the input socket of the equipment and in the case of velocity, directly through an adjustable attenuator to a three-stage transistor pre-amplifier of high input impedance. The amplified signal is then fed through another attenuator into three pairs of transistors with local negative feedback. The output of this amplifier goes to a metering stage in which the meter is in the negative feedback line to give good scale linearity. The amplifier output also goes to a separate amplifying stage for monitoring purposes. The circuit supply voltage is stabilised in three separate sections with Zener diode references. The gain stability of the complete circuit is exceptionally high and virtually independent of normal temperature or supply voltage variations.

The two attenuator sections are operated by a single control switch, the latter section operating first to prevent over-loading of the output stage and to improve the signal-to-noise ratio of the amplifier at higher input levels. The signal from the vibration pick-up is first passed through an integrating circuit for displacement measurement or a differentiating circuit for acceleration measurement and then is fed into the amplifier as before. The required characteristic of vibration, either displacement, velocity or acceleration is selected by a three-way switch.

An output jack connector to the monitor stage is provided so that the amplified signal can be displayed on a cathode ray oscilloscope, or used with a suitable analyser such as the a.f. analyser, Type 1401, or the octave band analyser, Type 1410, to determine the component frequencies or the frequency spectrum of the vibration.

The transistor vibration meter is housed in a compact and portable metal cabinet with polished metal bezels.

Circle **16** *for further details.*

Residual Chlorine Recorder

THE BM residual chlorine recorder, which has just been produced by The Paterson Engineering Co. Ltd., has been developed to fulfil the need for a unit which is strongly built and accurate in operation and yet requires very little maintenance. Operating on the bi-metallic cell principle, its design is considerably less complicated than that of instruments using colorimetric measurement.

It employs a small Perspex constant head chamber of orthodox overflow type in which the sample water is received and measured. From this chamber the water gravitates through the instrument, thus only sufficient head to deliver the water to the chamber is required, and in most instances, sampling pumps are not required. The incoming supply is controlled by a small valve manipulated from the front of the cabinet from where the flow is visible at all times. The water then passes to a larger mixing chamber, also of Perspex, in which it is thoroughly mixed with a reagent by a swirling action. The reagent used is a simple buffer solution to which is added a small percentage of a specially-developed compound known as BM 18 which prevents the formation of mould growth without affecting the chlorine residual. The solution is fed by gravity on a constant head principle through special drip valves from a vessel having sufficient capacity for an eight day supply.

The reagent treated sample water then passes to the specially designed BM cell where the chlorine is measured by two electrodes which produce current proportionately to the chlorine concentration. A special feature of the operation of this cell is the continuous automatic cleaning of the electrodes, achieved by means of the sweeping action of a mild abrasive which keeps the electrode surfaces polished. The cleaning medium is retained in full in the unit.

Two wire-wound drums with metallic brushes deliver the output from the electrodes, without the necessity of amplification, to an electronic indicator and recorder which incorporates a highly sensitive circuit. A circular chart calibrated from 0 to 1 part per million provides a seven-day record and a sweeping pointer gives rapid visual indication on a large peripheral scale. Adjustable contacts are fitted which operate warning lights when predetermined high or low level residuals are reached. Audible alarms and auxiliary relays can be similarly operated.

In cases where a reading of the total chlorine as well as the free chlorine is required a second reagent vessel is fitted and a solution of potassium iodide is used in addition.

Circle **17** *for further details.*

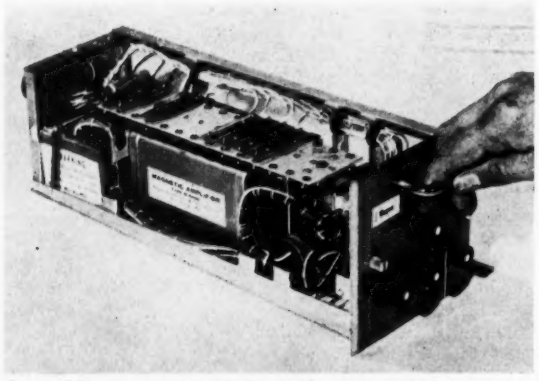
Solid State Analogue Computer Control Systems

A RANGE of entirely solid state analogue computer control systems are now available in this country from Hagan Controls Ltd. Under the name of PowrMag, these flexible control systems employ magnetic amplifiers in an electric analogue technique and are designed to complement digital computer control.

A typical PowrMag system would consist of four basic elements: input transducers converting numerous input variables such as pressures, flows, temperatures, etc., and converting them into 1-9 volt d.c. signals; an analogue control computer providing all the computing functions required for each control loop; remote control stations for remotely establishing set points as well as required manual control operations; final control elements such as electro-pneumatic and electro-hydraulic valves or power units.

Some of the many typical instances of where the PowrMag systems could be applied in industry are in centralised plant or multi-plant control, expansion of existing control facilities where pneumatic loops must be tied into new equipment, small single or multiple controller systems and systems requiring direct tie-in with data processing equipment.

Circle **18** *for further details.*

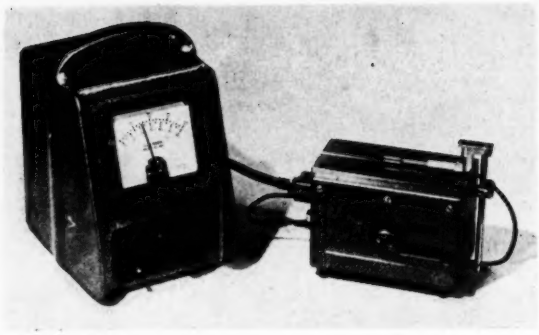


One of the range of entirely solid state analogue computer controllers known as PowrMag

Surface Measurement

A NEW surface measuring instrument, the Talysurf 105 manufactured by Taylor, Taylor & Hobson Ltd. uses an industrial diamond to provide a hard wearing and sensitive stylus.

A development of the previous model, this instrument has facilities for measuring interior surface irregularities, being capable of giving readings at points up to 11 in. inside bores of diameter down to 0·25 in. The instrument provides CLA readings with 0·3 in. cut off, and four measuring ranges are provided, 0—6, 0—20, 0—60, 0—200 micro-inches CLA.



Talysurf 105

To give the greatest sensitivity possible on fine surfaces, the diamond is ground to the smallest tip radius commensurate with the stylus forces required to bend the piezo element, this being between 0·00014 and 0·0002 in. The instrument therefore conforms closely to both British Standard 1134 : 1950 and the American Standard B46 : 1955.

Circle **19** *for further details.*

Soldering Iron Bit Cleaner

A NEW bit cleaner, for attachment to the standard iron rest, is now available for users of the A.N.T.E.X. precision miniature soldering irons.

This specially prepared brush, available at a list price of 3s. 3d., has been produced to ensure speedy and efficient cleaning, thus minimising bit wear, and effecting clean soldered joints. The iron rest, complete with cleaner, is listed at 15s. 9d., but is still available, without the cleaner, at 12s. 6d. as before.

In addition, another bit has been added to the range of interchangeable bits. The 6 bits now available are $\frac{3}{64}$ in., $\frac{5}{64}$ in., $\frac{3}{32}$ in., $\frac{5}{32}$ in., $\frac{3}{16}$ in. and $\frac{3}{16}$ in. HD.

Circle **20** *for further details.*

Optical Digitiser and Decoder

LINDARS AUTOMATION LTD. have produced an optical digitiser and decoder by means of which visual readings on a variety of instruments can be translated into digital form for the purpose of operating controls or producing records. Typical applications are the production of punched tape or cards and/or weight print-out by a weighing machine having a dial scale; the indication of angular position with remote visual indication; the remote weight setting on dial scales; data logging and machine tool control.

The digitiser is a self-contained totally enclosed unit which houses a transistorised printed-circuit amplifier. An aluminium drum containing twelve coded tracks is mounted on a precision ground shaft and twelve photo-electric cells inside the drum receive the light from a standard 60 watt lamp through the coded tracks. The output of each cell is amplified by a transistor and is transmitted to a relay decoder. When applied to weighing machines the circuit is so designed that the digital output cannot be obtained until the coded drum is stationary.

The decoder unit is housed in a separate case which can be rack or panel mounted. It receives the signals from the digitiser in coded form and translates them by means of relays into three decades 0-9. This can be converted by the fitting of additional equipment into avoirdupois, angles or fractions of the decimal output.

The decoder can be provided with or without an illuminated in-line indicator. Alternatively this can be supplied separately for panel mounting. The unit will also provide the feed for printed, typewritten, punched card or tape output and, if desired, will re-encode for a computer.

Circle **21** *for further details.*

Single Socket Sealectoboard

A QUARTER-INCH grid mounting individual socket has been introduced to complement the bussed sockets on the normal board. This has greatly increased the application flexibility of the Sealectoboard system of programme boards.

These isolated sockets may be used in combination with the bussed socket strips. Two or three deck Sealectoboards of any configuration can be specified with individual sockets on the lowest deck.

Alternatively, single-deck boards utilising the new sockets with patch-boards are now available to any specification.

The new socket follows closely the design of the original buss socket and its performance characteristics are identical.

Circle **22** *for further details.*

Electronic Die Saver

THE Radiovisor "Robotron" electronic die saver prevents die damage by continually monitoring power press operations and making sure that the component is ejected from the die before the press is allowed to commence the next stroke.

The unit consists of two parts (a) the control unit, (b) the detector head. The control unit is fundamentally a high frequency oscillator and an accurate fail-safe electronic timer. The control is connected to the detector head which is a carefully designed oscillator coil, the inductance of which is disturbed by the close proximity of moving metallic components.

A range of detector heads is available to suit many standard conditions and component sizes. All Type "A" heads are 1 in. or less in thickness, this permits mounting in restricted spaces. Heads for special purposes will be designed to meet individual requirements.

Each metallic stamped part passing through or over the detector head gives rise to an electronic signal which is fed to the control unit. This signal operates a relay which closes a set of normally open contacts, the relay remaining energised for a time period chosen to bridge the time interval between two components. As long as the electrical impulses are repeated within the set time interval the relay contacts stay closed. When an impulse is missed due to an ejection failure, the relay becomes de-energised and its contacts open to disconnect the press control circuit and stop the press. A sensitivity control adjusts the electronic circuit to take into consideration the size of the stamped part in relation to the area of the detection head.

The unit will operate at a rate up to 180 impulses per minute and higher speeds can be accommodated if required.

Where non-metallic parts are being pressed the high frequency detector head is not suitable and a photocell detecting system is employed. This system relies for its operation on the interruption of a light beam by the ejected component.

Circle **23** *for further details.*

Spray Booth

ALFRED BULLOWS & SONS LTD. announce the introduction of a new version of their Nopump spray booth.

This is a self-contained "packaged" unit which can be used virtually anywhere and it is the first Nopump booth of this type to be offered in this country.

The new booth is of monoform construction in 16 s.w.g. sheet metal and is 5 ft wide, 4 ft overall depth, and has a height of 9 ft 2 in. to the fan. It is offered in two versions; the standard bench type unit costs £260, and can be converted to full depth type quickly and easily by the use of a conversion kit which costs an additional £20.

A further advantage of this new Nopump spray booth is that the power consumption is less than that of a conventional water wash spray booth of the same size. The fan is driven by a 3 hp motor and the extract rate is 3,500 ft³/min at 3½ in. s.w.g.

Delivery is 4 to 6 weeks.

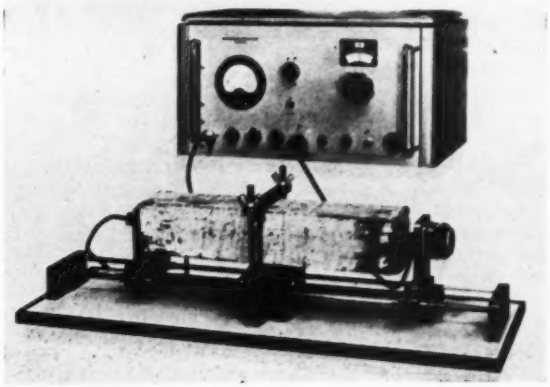
Circle **24** *for further details.*

Non-Destructive Materials Tester

A NEW non-destructive materials testing instrument is available from Cawkell Research & Electronics Ltd. This is the electrodynamic materials tester SCT 4, which covers a range from 100 c/s to 10 kc/s with calibration accuracy of ± 0·1%.

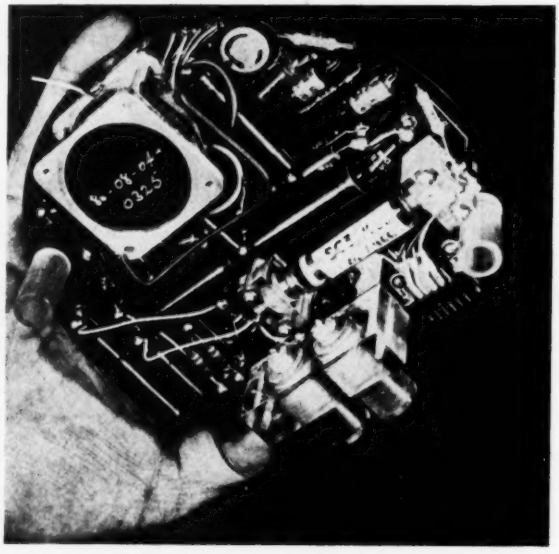
The SCT 4 gives an accurate measurement of the resonant frequency of a regularly shaped specimen. From this reading and a knowledge of the dimensions and density of the sample, the elastic constants (Young's modulus, modulus of rigidity and Poisson's ratio) may be calculated.

Non-destructive electrodynamic materials tester



The measurement is, of course, non-destructive and the effect of subsequent treatment of the material, such as irradiation in an atomic reactor, may readily be ascertained.

Circle **25** *for further details.*



EHT generator unit developed for space research satellite

E.H.T Generator for Scout Space Research Satellite

BRISTOL AIRCRAFT LTD. has designed for the Space Research Group at University College, London, an e.h.t. generator to be used in the Anglo-American space research satellite, UK Scout 1.

In upper atmosphere and space research, proportional gas counter tubes are used to detect radiation in the X-ray region. These tubes require a highly stable supply of around 1,600 volts. In short term experiments, such as those carried out with the upper atmosphere probe, the Skylark rocket, this voltage is generally supplied by dry batteries.

For satellite experiments, however, where the equipment is operating for perhaps a year, dry batteries are not stable enough and have an intolerably large temperature coefficient. Bristol Aircraft has, therefore, designed an e.h.t. generator for University College, London, to replace dry batteries.

The generator supplies 1,600 volts, stabilised by a corona stabiliser tube to within 1·5 volts of this level, against a primary supply change of ±15% about 6·5 volts. The output from a single transistor oscillator, working at about 8 kc/s, is stepped up by a transformer and voltage quadrupler, rectified and smoothed, the ripple amplitude on the output being less than 0·005%. The power consumption of the unit is about 80 milliwatts from the nominal 6·5 volts supply.

The current through the stabiliser tube is telemetered to obtain a measure of the output voltage, as it would be inconvenient to measure the 1·6 kV directly.

The unit is housed on a 5½ in. diameter board, the components being coated with polysulphide rubber before encapsulation in foamed resin to a depth of one inch. The foamed resin successfully suppresses corona discharge from high potential points during the launch phase while the pressure is being reduced to the vacuum in orbit. The potted unit is screened by a copper-coated top board and an edge screen of copper foil.

The unit has been satisfactorily tested over the pressure range from 1 atmosphere to 0·3 microns of mercury.

Circle **26** *for further details.*

Accounting Machine

A NEW all-purpose accounting machine, the National Class 33, enables business information to be analysed under many different heads as a by-product of routine accounting work. It also provides special facilities for the automatic production of "exception" reports, and thus simplifies the tasks of management control.

The machine has 21 adding and subtracting registers, 17 of which can be manually selected from the keyboard. Because of the advanced method of construction, up to four registers can be used simultaneously. All of them provide automatic credit balances and have the same high debit or credit capacity (up to £9,999,999,999 19s. 11d.) as the keyboard. Debit and credit balances, though printed in the same column, can automatically be accumulated separately if desired.

As in other National accounting machines, the operations of the Class 33 are largely controlled by an interchangeable programme bar which clips on to the carriage. This means that the machine can be switched from one application to another in a matter of seconds, making it particularly suitable for all-purpose accounting in small as well as large firms.

The Class 33 can perform nearly 100 different operations entirely automatically. One of these is the automatic checking of each line of entry. If the operator has inserted the wrong account form or has made a mistake in picking up balance or control figures, the machine totally rejects the incorrect information and returns to the starting position.

In addition, the Class 33 can be programmed to test the results of intermediate computations and, in the light of these, choose between alternative courses of action. For example, if it finds that an account is "in the red" or that stock of a certain commodity has fallen below safety level, it will immediately print an action note without any attention from its operator. This decision-making feature can be used to deal with exceptional items in all book-keeping and accounting operations.

Totals accumulated in the machine's 21 registers can be printed out (with or without clearing the registers) simply by pressing a single key. Four of the registers can be allocated to automatic serial numbering, so that four different sets of serial numbers can be employed during one posting run.

Circle **27** *for further details.*

Logarithmic Electronic Recorder

A BRITISH designed and made electronic strip chart recorder, with alternative logarithmic or linear response,

is announced by Honeywell Controls Ltd. It is intended mainly for research applications.

The recorder has two slidewires fitted in the standard position and the pen carriage is fitted with two sets of slidewire contacts. One slidewire is included in the measuring circuit, and to obey a logarithmic law, it is wound in twelve linear sections, each section having wire of different gauge or material. The law accuracy of the logarithmic slidewire is better than 0·4%.

The second slidewire is of linear construction and this is connected to a d.c. power pack from which a negative bias voltage is applied to the final voltage stage of the amplifier via the second set of slidewire contacts. Thus the magnitude of this bias voltage is relative to the pen carriage position and so provides automatic amplifier gain control to maintain stable operation over the full-scale travel.

A two position switch is incorporated in the measuring circuit to provide logarithmic or linear working. The new logarithmic/linear recorder has a calibration accuracy of better than 1% but to maintain a repeatable accuracy of 0·25% over the full scale the minimum span is restricted to 5 mV.

Circle **28** *for further details.*

Transistor Tester

THE latest test equipment from Advance Components Ltd. is the T.T.I. transistor tester. The T.T.I. has been specially designed for testing low and medium power transistors while still in circuit. This not only saves considerable time, but eliminates the risk of physical damage, particularly to printed circuit boards when removing a transistor for testing in the normal manner. Both p-n-p and n-p-n transistors can be tested. Grounded emitter current gain may be measured in or out of circuit and leakage current (grounded emitter) with the transistors out of circuit. The probes are a feature of the tester and their design was the result of a special user research by electronic engineers. The tester is battery operated and provision is made for checking the condition of the batteries. Retractable legs are fitted to the front of the instrument for bench working.

Transistor tester Type T.T.I.

Current Gain (Beta)
In two ranges 5—50
50—500
Accuracy ± 5% (transistor out of circuit)
Accuracy (transistor in circuit) dependent on base shunt circuitry

Set Current
Normally 1—10 mA but 10 mA not obtainable with transistor betas below 12, and 1 mA not obtainable with transistor betas greater than 200

Balance
Shunt collector circuits of greater than 100 ohms may be balanced out

Leakage Current Measurement
(Grounded emitter I_{co}) 0—1 mA and 0—100 μA with transistor out of circuit

Circuit Protection
The circuit is protected so that the maximum battery drain is 110 mA and the meter is protected for overloads of greater than 500%

Size:
6 × 6½ × 7 in. (15 × 16·5 × 18 cm)

Weight:
6 lb 6 oz (3 kg)

Price:
£40 0s. 0d. nett. in U.K.

Circle **29** *for further details.*

Transistor and Semiconductor Washer for Line Production

DURING semiconductor production several cleansing operations are essential before final assembly. Ultra pure water of the order of 16 megohm-cm is required at considerable flowrates. The unit must be self-contained and compact, with maximum flexibility for positioning.

In the Elgastat recirculator, Type B.106/GL the process water is recirculated with economy. From the storage tank the water passes through a mixed bed column to the washing chamber. Conductivity measurement of the freshly deionised water is followed by similar control in the washing chamber. The control unit may be mounted with the instrument, or be located in a central control room. The ion exchange cartridge has a capacity indicator.

The Elgastat B.106/GL is housed in an aluminium frame measuring 29½ × 18 × 22 in., ready for connection to the users' own washing vessels and may be used for spray or flood wash, intermittently or continuously. Cost, complete with conductivity monitors is £187 per station.

Circle **30** *for further details.*

Transformers

BLACKBURN ELECTRONICS' transformers provide a stabilised a.c. 50 cycles power source with a sinusoidal

output waveform. They are designed to supply power to electronic and electrical equipment, sensitive to mains amplitude and waveform variations of a repetitive or a transient nature.

A new design technique permits the regulation and the harmonic content of the output waveform to be kept to an extremely low figure, whilst the very high stabilisation ratio is maintained, irrespective of the power factor of the load.

Circle **31** *for further details.*

A.C. Converter Voltmeter

THE Solartron a.c. converter voltmeter Type LM 903 measures a.c. voltages (0—500 V) over the frequency range 20 c/s to 5 Mc/s. It was primarily designed to operate in conjunction with Solartron digital voltmeter LM 902.2 to give 4-figure digital display of a.c. voltages from 100 μV to 500 V (in 5 ranges). The measuring accuracy, when used with the LM 902.2 is ± 0·25% (50 c/s—100 kc/s) and ± 2% (20 c/s—750 kc/s) of full scale on each range, with useful indications up to 5 Mc/s.

Operating alone the a.c. converter voltmeter covers 0—15 mV to 0—500 V in 10 ranges, with ± 2% measuring accuracy on the built-in meter. The input impedance is 1 MΩ shunted by approximately 40 pF.

Fine pre-set controls and an internal calibration voltage permit accurate initial setting of the instrument prior to being used either on its own or with the digital voltmeter. A coaxial socket permits monitoring of the amplified a.c. signal on an oscilloscope.

Although supplied as bench units, the a.c. converters LM 903 (and digital voltmeter LM 902.2) are easily adapted for standard rack mounting. Mains input 110/220 V ± 5, 10, 20 volts, 50—60 c/s. The dimensions are $9\frac{1}{2} \times 18 \times 16$ in. (bench models), $8\frac{3}{4} \times 19 \times 16$ in. (rack mounted), weight 43 lb.

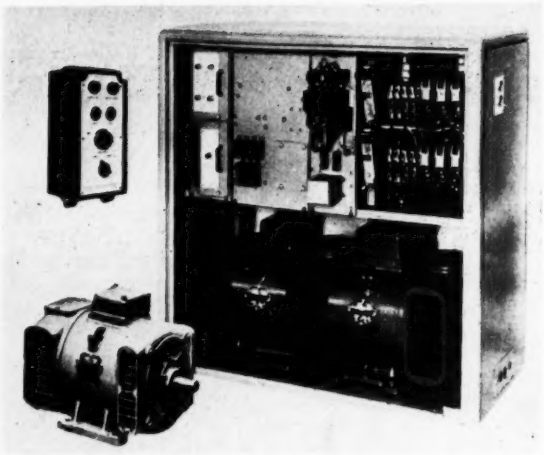
Circle **32** *for further details.*

A.C. converter voltmeter

"Transidyne" Drive

IN one package, complete with integrally mounted motor-generator, the "Transidyne" drive, manufactured by Lancashire Dynamo Electronic Products Ltd., is now fully rationalised in all ratings from 1—10 hp.

A wide variety of alternative control characteristics is also available, the desired features being assembled into the cubicle from a range of "off-the-shelf" sub-assemblies and plug-in control units.



Transidyne motor speed controller

Using semiconductor control techniques throughout, these drives are especially suited to applications involving overhauling loads since regenerative braking is provided by the inherent characteristics of the motor-generator arrangement.

The "Transidyne" drive is supplied complete with a remote mounting control station which provides pushbutton starting, reversing and fingertip speed setting.

Circle **33** *for further details.*

Proportional Controller

FOR stepless proportional control of electrical loads using a magnetic amplifier and a saturable reactor, a new millivoltmeter instrument known as the Pyr-O-Volt is announced by Honeywell Controls Ltd. It is an indicating instrument.

The Pyr-O-Volt controller 105R12 is an inexpensive current-proportioning instrument with no contactors. It has a continuous output of 3—7 milliamps working into an impedance of 4,000 ohms or more when used as the input to a magnetic amplifier. It will control saturable core reactors up to 100 kVA, with provision for control of larger reactors.

Among important features are the straight line control, automatic fail-safe, built-in voltage regulation, plug-in design, adjustments on the instrument itself, connection and servicing from the front.

In the same family is another new instrument, the millivoltmeter indicator 105X11, which has a high quality moving coil movement and a plug-in design.

Circle **34** *for further details.*

Direct Reading Frequency and Capacitance Meter

THE portable, battery powered meter Type MM 1009, recently produced by Solartron Laboratory Instruments Ltd., gives direct readings of frequency (0—100 c/s to 0—100 kc/s) and capacitance (0—1000 pF to 0—0·3 μF).

As a frequency meter it has a ± 3% measuring accuracy on 5 ranges up to 10 kc/s and ± 5% on the

two ranges above. These accuracies hold for a 2 : 1 spread in mark/space ratio. The input signal (100 mV—150V r.m.s. amplitude) is limited and fed into a pulse counting type integrator circuit. With a suitable input transducer this direct reading frequency meter could be adapted for numerous applications in tachometry.

As a capacity meter the MM 1009 covers the range 0 to 0·3 μF in six ranges with a ± 2·5% accuracy maintained over the battery range 12 V to 8 V. The unknown capacitor is compared with the internal standard by substitution in the integrater circuit. Suitably chosen standards thus provide accurate direct readings of capacitance. The range is easily extended to 1·0 μF.

Semiconductor devices are used throughout and the meter is powered by 8 leakproof U2 cells (International Standard) or equivalent, giving a useful operating life of three months. Overall dimensions are $6\frac{3}{4} \times 9\frac{7}{8} \times 5\frac{1}{2}$ in., weight 6lb.

Circle **35** *for further details.*

Dataplotter

A NEW, compact, low-cost digital plotter is being offered by Electronic Associates Ltd. The Series 3100 Dataplotter provides improved accuracy and speed for converting data from any digital computer system to graphic displays of engineering tests and problem solutions, sales, production and cost data.

Able to accept analogue as well as digital inputs, the Series 3100 Dataplotter provides accuracies up to 0·175% of full scale on 11 × 17 in. X-Y plots of digital data and permits plotting speeds up to 80 points per minute. This new, low-cost unit is equipped with transistorised control circuitry, provisions for "off-board" origin, and is able to receive punched card, tape or keyboard input.

Circle **36** *for further details.*

Relief Valves

A RANGE of relief valves has been added to the range of Norgren air line filters, regulators and lubricators.

The range of these relief valves is from $\frac{1}{8}$ in. to 1 in. pipe sizes, from low capacity relief to a maximum relief flow of 250 ft³/min at 100 lb/in². It includes the Series 40AC pilot operated relief valves which can be controlled from a convenient position using Norgren piloting regulators.

The many accessories for these units include pressure gauges, wall mounting brackets, tamper proof caps and panel mountings for concealed fitting of the units. Plastic handwheels are available for Series 62AX and knurled adjusting screws and locknuts for the Series 40AB.

Circle **37** *for further details.*

Filter-Regulator Unit

THE filter-regulator unit, Series 73AC from C. A. Norgren Ltd. is based on the operating parts of the 30AF Type filter and 20AG Type regulator. By combining these two units into one body a compact unit with high filtering and regulating efficiency has been obtained. The flows and pressure drops through the filter section are the same as those for the 30AF filter, whilst the flow and regulation characteristics of the regulator part of the unit are the same as those for equivalent pipe size of the 20AG Type regulator.

The unit is available with plastic or metal bowl and with standard or relieving type regulator. Additionally, a total of five types of filter element are available, together with three spring ranges. It should be noted that the input pressure to the unit is set by the type of bowl fitted, being 150 lb/in² for the transparent bowl and 250 lb/in² for the metal bowl. The respective maximum working temperatures are 120°F and 200°F.

All accessories available for the 20AG Type regulators are also available for these units.

Circle **38** *for further details.*

Water Meters

A RANGE of full flow water meters designed specially for use in any pipeline having a high flow rate and requiring minimum head loss conditions has now been introduced by Parkinson Cowan Measurement.

Four sizes of the meter, known as the Type 33, can handle flows of from 800 to 200,000 Imperial gal/h and have simple two-bolt Victaulic joints for easy installation in any pipeline. Each meter is individually tested, calibrated and guaranteed to measure its recommended flow range with a maximum error of not more than ± 2%. The size of meter for a particular pipeline is determined by the continuous maximum flow rate and not pipe size.

Type 33 meter operation is based on a helical rotor mounted in plastic bearings on the meter body axis. The rotor revolves at a speed directly proportional to water flow velocity and the rotary motion is transmitted to the index via reduction gears and a stuffing box. The gear mechanism and bearings are made from a special plastic material which eliminates friction and corrosion as well as reducing wear.

Straightening vanes at the meter inlet prevent turbulence which could cause inaccuracy and a regulator is provided to give fine calibration adjustment. Only two bolts have to be removed from the Victaulic joints before the whole meter assembly can be removed for inspection, testing and calibration.

The Type 33 meter can be used with a wide selection of indicating and controlling devices such as a multi-pointer or direct-reading totalising index, a mechanical graphic recorder, a rate of flow indicator, a strip chart recorder, a manually or automatically resettable index for batch control, an electro-magnetic summating counter—arranged singly or in series—and a series of Dekatron tubes which can be pre-set to a batch quantity by means of rotary switches or punched cards.

Circle **39** *for further details.*

Decade Counter Tube

FURTHER development of the "Elesta" decade counter tube, EZ.10A, and of the counting principle with single pulses has resulted in the decade counter tube, EZ.10B. The new model, EZ.10B, can be used for counting speeds up to 1 Mc/s.

Despite the fact that all tubes of Type EZ.10 function quite well and uncritically in most circuits, it is very important to use well adapted circuits for highest

reliability and operating life. It is particularly important not to use the EZ.10B in the same circuits as the EZ.10A. The EZ.10B has a different anode current range and its auxiliary cathode bias is provided in another way. The EZ.10A will have a very short operating life in EZ.10B circuits despite the fact that initially it will work quite satisfactorily, whereas the EZ.10B would develop a tendency to erroneous counting in EZ.10A circuits.

The anode supply voltage of 580 V corresponds to twice the sustaining voltage of the tube. It may be obtained by the series connection of two 290 V d.c. supplies. The relatively high supply voltage is necessary to keep the anode current within the necessary limits despite line voltage variations. Stabilised anode supply voltages may be as low as 400 V d.c., provided the anode resistor is decreased correspondingly.

The EZ.10B needs a sufficiently high auxiliary cathode bias for reliable operation. This bias should not be below 30 V and even considerably higher for the fast input stages.

For electrical read-out of the glow discharge position and preselection cathode resistors are inserted between the individual cathodes and 0.

Basically, the counting mechanism of the counter tubes EZ.10 is not critical as regards to shape and amplitude of the driving pulses.

Approximately rectangular pulses are to be preferred, because a slowly rising voltage at the end of the negative pulse at amplitudes at which the transfer takes place may result in double transfers. Pulse duration and coupling capacitors should be so chosen that the employed pulses are coupled to the auxiliary cathodes without too much distortion.

The voltage rise speed of the pulse front of the driving pulses for the EZ.10B should not exceed 10^9 V/sec.

The pulse amplitude corresponds, for slow and medium speeds, to the nominal value (100 V) given on the data sheet. For very high counting speeds larger pulse amplitudes (about 200 V) are needed. In this case the anode current range is slightly reduced because of the increased peak currents.

The duration of the input pulses for counting speeds of less than 1,000 c/s is usually increased to 0·1-1 millisecond. Pulses of this length can be produced in particularly simple and uncritical circuits.

The amplitude of the main output pulse is approximately 7 V.

Circle **40** *for further details.*

Miniature Push-button Switch

THE miniature push-button switch, Type 500, from AB Metal Products Ltd. is available with 3-pole change-over per button and can be supplied with the number of buttons required up to a 6-way unit, larger units can be produced to special order. The Type 500 may be used for transistor radios and remote control assemblies where space is at a premium.

Circle **41** *for further details.*

Shaft-Position Encoders

THE Norden Division of United Aircraft Corporation have introduced a new range of shaft-position encoders now available in the U.K. through Ketay Ltd.

Applications for these devices embrace machine tool control, film readers, and all types of navigation device, including those for the measurement of such variables as heading, bearing and azimuth.

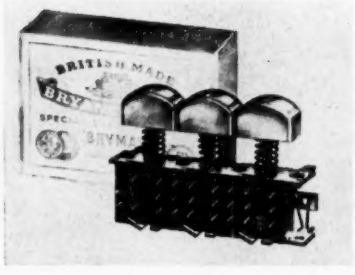
Type ADC-36BCD provides 360 discrete counts per rotation of the input shaft, numerical indication of shaft position being given in degrees in 8-4-2-1 binary coded decimal code. Self-selecting V-brush logic is incorporated, so obviating the need for extensive external brush selection logic circuitry. The encoder is contained in a size 33 standard U.S. Bu-Ord synchro mount through the use of the split-bit technique.

Type ADC-5-BCD (1000) is capable of 100,000 counts in only 100 turns of the input shaft. Like the previous type, this uses a self-selecting V-brush logic and the split bit technique again permits incorporation of this high-resolution encoder into the smallest container possible. It is basically a 1,000 count per turn device.

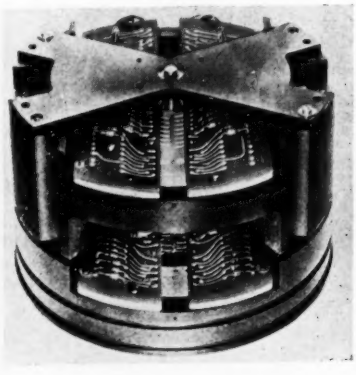
The third type, providing 1,024 counts per shaft

◀ *Decade counter tube*

Miniature push-button switch ▼



Shaft-position encoder



rotation, is contained in a standard U.S. Bu-Ord size 33 synchro mount and gives an output in Gray Code. This device supplements the Ketay range of Gray Code encoders which includes a size 18 providing 256 counts and a size 23 providing 512 counts per turn.

Circle **42** *for further details.*

Automatic Feed Control Equipment

AN automatic feed controller which has been specially developed for use in the pulverising, grinding and milling industry is announced by Lancashire Dynamo Electronic Products Ltd.

In operation, the mill motor loading is accurately measured by means of a current transformer and the controller provides stepless and accurate adjustment of the speed of the feed motor, so maintaining the desired mill loading as set at the control station.

A unique instantaneous overfeed protection system is incorporated which enables the loading to be maintained much closer to the full mill rating than was hitherto possible.

The equipment is manufactured in its standard form in a range of ratings from 0·5 to 4 hp, the smaller ratings being suitable for wall mounting. A wide range of motors is also available, including totally enclosed types, and these can be supplied complete with suitable gearheads where required.

Circle **43** *for further details.*

Electrical Measuring Instruments

THE new 38 CY series of electrical measuring instruments made by Measuring Instruments (Pullin) Ltd., is now in full production. A recent development is the availability of colour for the lower section of the instrument cover. Besides the standard black, single instruments can be supplied in a preferred range of colours, or bulk quantities in any colour, to customer's specification. This means that the Crystal range, as it is known, can be made to match in with the instrument panels, or if required all volt meters can be signalled by one colour and ammeters by another. A single vital instrument in a complex instrument panel can be clearly singled out, by for example, red identification.

The dials in the 38 CY range have been designed to give clear viewing from 4½ ft, though the outer diameter of the instrument is under 5 in. and the scale length 3·8 in. Three types of movement are avai¹ ble, moving coil d.c., moving coil a.c., rectifier and moving iron a.c./d.c.

Circle **44** *for further details.*

"Minilog" Mark II

PANELLIT LTD. have available a fully-encapsulated version of the "Minilog" solid state transistorised logic system for industrial sequencing and control applications.

"Minilog" can be applied to both simple and complex logic systems. It is designed to replace relays, stepping switches and similar devices, increasing both speed and reliability of performance. It is completely solid-state, requires no maintenance and ensures trouble-free operation under stringent environmental conditions.

Two types of "Minilog" elements are available. One has six inputs, giving an "inverted and" function, and drives up to five outputs; the other incorporates an emitter-follower and can drive up to twenty-five inputs. Both are exactly the same size (2·0 × 0·85 × 0·63 in.) and occupy slightly more than one cubic inch of space. They have eleven tinned-copper wire leads, 0·32 in. in diameter. Transistor power elements can be supplied as top- and bottom-end drivers for actuating solenoids and similar devices up to a maximum of 50 volts 1 amp.

Forty-eight "Minilog" elements can be mounted on a S.R.P.B. board, measuring 10 × 17 in. A special "Minilog" chassis, with gold-plated plugs and sockets to provide inter-board, signal and power connections can accommodate up to twelve of these boards.

Circle **45** *for further details.*

Temperature Control System

NO moving parts are used in a temperature control system employing the Fielden "Bikini" temperature controller and a saturable core reactor and temperature control of circuits of up to 10 kW can be achieved.

The "Bikini" controller and saturable core reactor operate from a robust stainless steel measuring bulb of ¼ in. diameter and two types are available, one for use at temperatures up to 500°C and the other for temperatures up to 850°C. The controllers are available in 73 ranges covering temperature spans as short as 50°C and as wide as 600°C. The control differential is only 0·5°C and if desired the controller can be located as much as 300 ft away from the measuring point.

Circle **46** *for further details.*

Indicating Lamps

EVERETT EDGCUMBE & CO. LTD. now have in production a range of push buttons and transformer operated indicating lamps suitable for mounting on any form of switchboard, control desk or panel. The push buttons are rated at 5 amperes 600 volts, are available with projecting or flush buttons, and are oil tight. Provision can be made for "locking off" by turn button or by a built-in barrel lock.

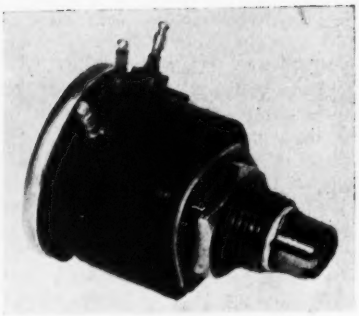
The indicating lamps each have a small single-phase step-down transformer built in to the assembly, the output voltage to the lamp being only 12 volts. This enables a miniature lamp to be used with a consumption of 2·2 watts, thus ensuring long life and reducing, considerably, the heating problem as often encountered with lamps at higher voltages. The transformer can be supplied suitable for primary voltages of 100/125, 200/250, 400/440 or 500/550 volts. Unbreakable lenses in Diakon, are available in five colours, the lens being removable to permit lamp replacement from the front.

Circle **47** *for further details.*

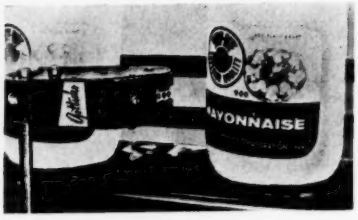
Miniature Wirewound Control

GENERAL CONTROLS LTD. are now producing a miniature wirewound control that will dissipate 3 watts.

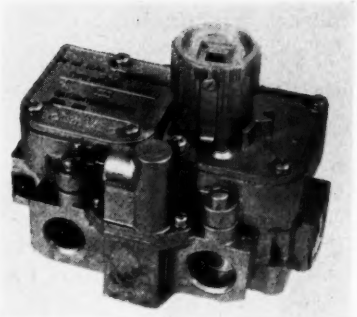
The size of this control is 0·916 in. in diameter by



Miniature wirewound control



Rolacoder miniature coder



Gas control unit

0·660 in. deep, and is fitted with a special silicone glass laminated former, a brass "turned on" lid, and can either be supplied with turret lugs, solder tags, fly away connections, or suitable for direct insertion into printed boards.

The housing is moulded in mica loaded material X4933/4, and can be supplied as a fully-sealed tropicalised unit, with a maximum resistance value of 50,000Ω.

These are being manufactured 100% at Basildon and delivery in large quantities can be made within 14 days from receipt of order.

Circle **48** *for further details.*

Miniature Coder

A NEW miniature coder, namely the 450 Rolacoder, is only $4\frac{1}{2} \times 1\frac{3}{4} \times 1\frac{1}{2}$ in. overall. It can give a very high quality code imprint.

Its compact design makes it easy to fit to turret or roll through labellers, cartoners or wrappers, and its re-cycling mechanism with can latch release will position the imprint in the same place on each succeeding product.

The Rolacoder 450 may be installed vertically or horizontally, to imprint from above, below, or either side. A reservoir ink roller is incorporated which will last half a day of continuous high speed operation, and by using a spare reservoir roller, the unit can be re-inked within about 15 seconds.

The Rolacoder makes a sharp imprint reading parallel to the line of product travel, whether the product flow is continuous or intermittant, spaced or butted, It uses special "flange-groove" rubber type in 1/16, 3/32, 1/8 and 3/16 in. sizes; letters or figures are available.

By agreement with Adolph Gottsho Ltd. of New Jersey, these machines are being handled in Great Britain, Europe and the Commonwealth, by Mark-o-Print Ltd.

Circle **49** *for further details.*

Gas Control Unit

THE General Controls B64YA gas control is four valves, plus a pressure regulator in one compact unit:

1. main line manual gas cock
2. main line automatic valve
3. pilot line shut-off valve
4. main line 100% safety shut-off valve
5. pressure regulator

Pilot gas adjustment and pilot gas filter are optional features.

B64YA valves may be used on applications such as room heaters, appliances, wall heaters, floor furnaces and other gas fired equipment. They may be used with all types of gases, including LP and sour gases. Maximum ambient temperature is 175°F, 79°C. Valves have spring loaded diaphragms and mount in any position.

This unit is entirely independent of mains voltage and depends for its electrical power (milli voltage) on General Controls, G.250A thermocouple generator, which develops a fast positive output when heated by a pilot flame. The main line automatic valve opens and closes in response to thermostat and other controls which may be wired in circuit.

Circle **50** *for further details.*

New Encapsulation Technique

RIVLIN INSTRUMENTS LTD. have recently developed and introduced a new method of encapsulation, based on epoxy resin which has the following advantages: Wide temperature range with proof against high humidity—suitable for use in the temperature range of −55 to +120°C with or without humidity, without significant effect on accuracy and stability. The new range is completely interchangeable with the existing RIL Types (1—9) and all dimensions are exact and repeatable within very close limits.

All terminations are gold plated to prevent oxidation during storage and to facilitate soldering without irksome preparation.

Circle **51** *for further details.*

Helical Potentiometers

RELIANCE have available a new potentiometer—the HEL.07—10 which requires 10 turns of the spindle, each of 360°, to cover the full resistance range and due to the design and construction, backlash is said to be eliminated and accurate re-setting is easily achieved.

The standard models cover a range of 100—30,000 ohms with a tolerance of ± 5% and with the whole element uniformly loaded, the rating is 2 watts at 20°C ambient.

Accuracy is within ± 1·0% on the standard models whilst specials can be supplied to within 0·25% if required.

The overall dimensions are 2 in. long by ¾ in. diameter, the whole being housed in an anodised case.

Additional models to the range are under development and will be for servo application with extremely low torque, ganging and tapping facilities and in synchro sizes 11 and 15.

Circle **52** *for further details.*

Electronic Timer

THE electronic timer Type TY is an addition to the Londex range of timers.

It is available in three forms:

(a) In a steel case suitable for wall mounting. (Units are normally supplied in this form, unless otherwise specified).

(b) In a steel case suitable for bench mounting.

(c) On a steel front panel without cover, suitable for flush mounting on the front of control panels or consoles, etc.

The dial on the front is engraved and calibrated in actual time. Connections are made to a shrouded terminal block fitted on the front panel. The essential components are a multi-tapped input transformer, a thyratron, and a timing condenser and resistance. Two Londex relays are included which enable a multiplicity of switching sequences to be obtained.

Five standard time ranges are available and each will give a very wide ratio of adjustment. The maximum-minimum ratio is 30 to 1.

The ranges are as follows:

TY/1 4 seconds to 120 seconds, the dial calibrated in 4 seconds divisions

TY/2 2 seconds to 60 seconds, the dial calibrated in 2 seconds divisions

TY/3 1 second to 30 seconds, the dial calibrated in 1 second divisions

TY/4 0·5 to 15 seconds, the dial calibrated in 0·5 second divisions

TY/5 0·25 to 7·5 seconds, the dial calibrated in 0·25 second divisions.

An electronic timer takes a finite period to recharge its timing condenser. This varies with the time range, and the recommended minimum values are:

6·0 seconds for the type TY/1
4·0 seconds for the type TY/2
2·0 seconds for the type TY/3
1·0 seconds for the type TY/4
0·5 seconds for the type TY/5.

The accuracy remains substantially unaffected by the usual mains voltage fluctuations. The setting accuracy is ± 5% of any given settings, or ± 0·06 second, whichever is the greater. This means, that if the pointer is set to a particular period, the time obtained will be within these limits.

The cost of the wall or bench mounting unit is £14 15s. plus 7½% nett. The price of the flush mounted timer is £13 10s. plus 7½% nett.

Delivery is eight weeks.

Circle **53** *for further details.*

Pressure Gauge

A NEW pressure gauge has been introduced by Buchanan Brothers Ltd. It is known as the "Clyde" economy pressure gauge, so-called because of its low price.

The new pressure gauge uses a tube with a conventional quadrant and pinion mechanism. The movement of the tube is transferred to the quadrant by means of a locating pin attached to the tube and moving within a slot in the tail of the quadrant.

The gauge has a flange back and a brass lacquer finish as standard. Block and dial screws are concealed. A full range of British Standard pressures from 60 lb/in² to 600 lb/in² are available, and the scale markings are of the Easiread type, first introduced by the company.

The model just introduced is of 4 in. dial size and the company plan to add a 2 in. and 2½ in. model within six months. Present price of the 4 in. model ranges from 17s. 3d. for quantities of 1,000 plus, and quantity delivery is currently four weeks.

Circle **54** *for further details.*

Low Impedance Reference Battery

MALLORY BATTERIES LTD. announce the production of a new mercury type voltage reference battery.

Rugged, non-glass construction enables the Mallory reference battery to withstand brief short circuits, severe vibration and physical shock without damage. It operates in any position and is fully portable.

Two sizes are available—a single cell 1·35 volt battery, and one with 8 outputs from 0—10·80 volts in 1·35 volt increments. Accuracy of ± ½% of stated open circuit voltage is claimed; temperature stability within 1% from −20 to +160°F at drains up to 100 microamperes.

The Mallory reference battery is guaranteed for two years and will be supplied by Baird & Tatlock (London) Ltd.; A. Gallenkamp & Co. Ltd.; W. B. Nicolson (Scientific Instruments) Ltd.; J. W. Towers & Co. Ltd. Prices are £4 for the single cell, £10 for the multi-voltage.

Circle **55** *for further details.*

Flameproof Hand Inspection Lamp

THE flameproof hand inspection lamp, manufactured by Messrs. J. M. Hargreave, has a "Buxton" certificate for use in atmospheres of Groups II and IIIa gases.

Its overall length is 18¾ in., 2½ in. in diameter and it weighs less than 3 pounds. Thus with the high light output from its 8 watt flourescent tube and by virtue of its compactness it is suitable as a background safety light and also as an unobstrusive on-the-spot working light. The accompanying ballast unit can be also flameproof or not, according to its situation with regard to the hazardous area.

It is produced for use with standard voltages of 230/250 volts a.c. and 24/28 volts d.c. but other voltages can be accommodated by arrangement with the manufacturers.

Circle **56** *for further details.*

Annunciator Units

MOST industrial processes require a warning to be given if one or more variable such as pressure, level or temperature rise or fall below a preset value. For this purpose units such as pressure and level switches etc., are provided which operate their contacts when a danger condition is reached. The SIG/O and SIG/C annunciator units have been designed by Londex Ltd. to operate in conjunction with any of these contact devices.

The SIG/O unit is for use with initiating contacts which close, and the SIG/C for contacts which open on alarm condition.

The SIG/O and SIG/C annunicator units are completely self-contained, and incorporate a red and green warning lamp, as well as output contacts for controlling an audible alarm. When the initiating contact is in its normal condition the green lamp on the annunciator unit is illuminated. When the initiating contact operates, the green lamp extinguishes, the red lamp illuminates, and at the same time the alarm relay contact within the unit closes to control an audible warning.

On pressing the cancel button the alarm relay contacts re-open, thus silencing the audible warning, but the red lamp remains illuminated, giving visual indication that the danger condition still exists. The red lamp remains illuminated until the initiating contact resets, which causes the red lamp to extinguish and the green lamp to be illuminated.

An additional feature incorporated in these annunciator units is a TEST/NORMAL switch, enabling an alarm condition to be simulated at any time for test purposes.

To facilitate installation the annunciator unit has been designed in the form of a plug-in chassis, enabling it to be removed easily from the casing. This allows a clear access to the fixing holes and terminal connection block in the back of the casing.

A single phase a.c. supply between 200/250 V is required, and the switching capacity of the audible warning output contact is up to 3 amp at 250 V a.c.

The equipment is suitable for wall mounting.

Circle **57** *for further details.*

Automatic Cleaning of Intricate Castings

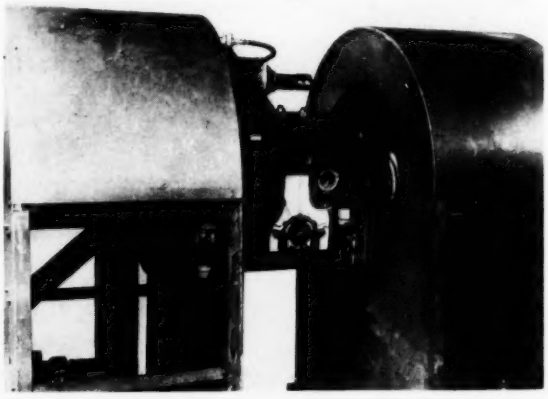
SINEX ENGINEERING CO. LTD. have recently developed a unit for the automatic cleaning of intricate castings that have been subjected to a number of machining processes.

As will be seen from the photograph it comprises a cage into which the casting is inserted and automatically clamped by pneumo-hydraulic rams. It is then subjected to vibration whilst it is turned through 360° and returned by limit switches. Rotation is by means of a reversible geared motor unit and chain drive. The vibration is isolated from the supporting structure by the use of normal motor tyres and rotation takes place on the stub axle bearings associated with the wheels.

The most interesting feature of the design is the use of two contra-rotated rotary electric vibrators which, when they are inclined at approximately 30° to the vertical, provide a conveying action. Indeed, the cage becomes an orthodox vibratory conveyor. Similarly, when the vibrators are inverted and inclined at 30° they become a conveyor in the opposite direction so that the swarf and any core sand or steel shot remaining in the labyrinths of the casting receive a strong feeding action. In these two positions the vibrators are self synchronising. In other positions they drop out of synchronism, thereby subjecting the cage and casting to a range of frequencies and consequently a range of amplitudes.

The unit has been designed specifically for a cylinder block casting of one type in quantity production, but the arrangement is adaptable to accommodate virtually any size of casting or range of castings, and can also be used for stress relieving castings or welded structures by vibratory shake-down, for which purpose the rotary action is not required other than as a frequency changing device, but of course the time cycles for stress relieving is of the order of hours whereas for cleaning, experiments show that single rotation with a time cycle of 30-40 seconds is adequate.

Circle **58** *for further details.*



Unit designed for automatic cleaning of intricate parts

Pressure Transducer

WEST INSTRUMENT LTD. have developed a new range of instruments for measuring plastic melt pressures.

Two types of instrument are involved: an indicating instrument and a pressure alarm system. Scale ranges of up to 10,000 lb/in² are available on both models.

The pressure indicating system consists of a Zener diode voltage regulator which excites a strain gauge pressure transducer mounted on the machine. This in turn excites a low-current, high-resistance indicating meter with a linear pressure scale. As the pressure changes, the four arms of the strain gauge change resistance and thus alter the input to the indicating meter.

The pressure alarm model incorporates the same system of indicating, but is arranged so that connection to a visible or audible alarm system is possible.

A switch is provided on the control chassis which allows a choice of automatic or manual re-setting. In the manual position, the alarm circuits will not re-set until the pressure has dropped and a push-button is pressed by the operator. Under automatic control, the

circuits will be re-set as soon as the pressure drops below the high-limit point.

Calibration of these instruments to the transducers is extremely simple and is well within the capacity of a machine operator.

Circle **59** *for further details.*

Remote Controlled Valves

HYDRAULICS & PNEUMATICS LTD. are manufacturing a range of complete units consisting of Fullway ball type valves, together with pneumatic or low pressure actuation for remote control.

The assembly comprises the double acting operating cylinder, an anchor bracket for attaching the cylinder to the pipe line, " U " bolts, flexible piping from the cylinder terminating in bulkhead unions attached to an anchor plate. The unions provided are suitable for the connection of $\frac{1}{4}$ in. outside diameter pipe (2 in. bore cylinder) and $\frac{1}{2}$ in. outside diameter pipe (3 in. bore cylinder).

The final distance must be adjusted so as to ensure that in the fully open or fully closed position the cylinder movement is stopped within the cylinder and not against the stops of the Fullway valve.

The type of control valve selected for operating the cylinder will depend upon the particular method of control required.

Fail safe arrangements can be designed to meet particular requirements.

Circle **60** *for further details.*

Construction System

ALFRED IMHOF LTD. have developed a completely new construction system, miniature IMLOK. This is based on the established principles of their IMLOK construction system (a series of die-cast aluminium connectors and interlocking aluminium extrusions) but is to a new design and while it is ideally suitable for the construction of units as small as $4\frac{1}{4}$ in. cube, it is equally suitable for much larger structures.

Initially there is a choice of 12 extrusions and 2 connectors. These extrusions offer a choice in the appearance of the finished framework. They cater for recessed panels, glass and other panels up to $\frac{3}{8}$ in. thick and door frames besides the normal external framework extrusions, most of which have a panel retaining groove for 20 s.w.g. panels. There are also a series of spacer bar extrusions to permit large panel areas to be broken up. Most of the extrusions are " square " in appearance.

Circle **61** *for further details.*

Stabilised Power Supply

A NEW 30 V, 3 A fully transistorised power supply unit has been developed by Rotax Ltd. One of its features is a new filter circuit which enables the number of transistors used to be kept to a minimum, resulting in greater simplicity and overall reliability. The stabilised voltage output is variable from zero to maximum, overall stability factor 1: 1,200, and d.c. resistance less than 0·01 ohm. Adjustable overload protection is provided.

Circle **62** *for further details.*

Recording Methanometer

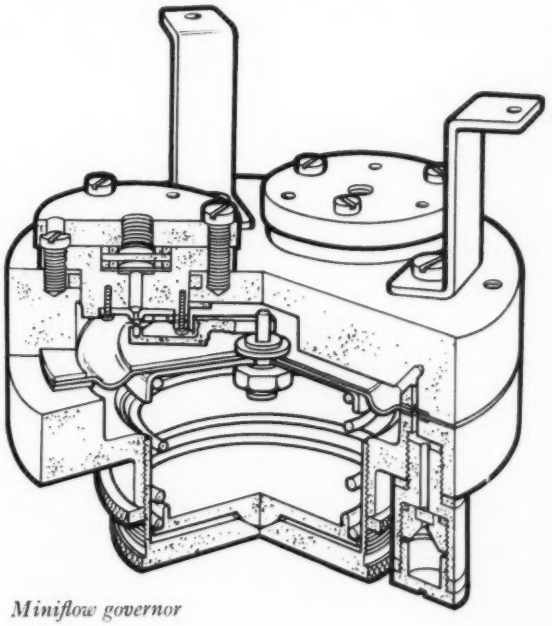
THE Mining Research Establishment of the National Coal Board has developed a recording methanometer which detects and records continuously, the presence of combustible gases in the atmosphere. The instrument is now in production and is manufactured by The Sigma Instrument Co. Ltd. under licence from The National Coal Board.

The recording flame methanometer installed in mines or industrial plants will give an accurate and visible record of up to 3% of combustible gases in the atmosphere. It will run for seven days without attention, maintenance is surprisingly simple, needing no great technical knowledge or skill. It is proof, however, against tampering by unauthorised persons.

The basic principle of the instrument is a constant burning butane flame, in a gauze chamber, and fed from a high pressure butane tank. The jet and the flow of the fuel is controlled by the precision built Sigma Miniflow governor which maintains in uncontaminated air a non-varying flame.

The hot waste fumes from the flame pass a ring of thermocouples. With unpolluted air the temperature of the flame and waste fumes remains constant and the pen recorder, connected electrically to the thermocouples, gives a continuous zero reading. When the air supply to the burner is contaminated by combustible gas there is an increase in the temperature of the flame and of the exhaust fumes. The increase in temperature of the exhaust fumes increases the output voltage of the thermocouples and the recorder pen is deflected. A continuous recording is made on a calibrated chart giving the density percentage of combustible gases present. These recordings are accurate with 0 to 3% of combustible gas present.

A special laboratory model is also in production



Miniflow governor

which will provide a visible and audible indication of the presence of combustible gases in the laboratory. The Miniflow governor used in the Sigma recording flame methanometer to ensure a constant and unvarying flow of butane gas is also manufactured by Sigma under licence from the N.C.B.

Circle **63** *for further details.*

Transistorised Tuning Fork

THE tuning fork from Bryans Aeroquipment Ltd., provides stable 50 cycle reference frequency and can be used in the following applications:

(1) in tachometer testers operating on the stroboscopic principle
(2) as a reference signal for accurate speed control of 50 cycle synchronous motors
(3) in time control equipment.

It does not require any additional power pack or any other power supply, e.g. batteries, as it operates direct from mains. It does not use contacts to maintain the fork in oscillation and, in consequence, it is free of the disadvantages of tuning forks using contacts which cause wear, variation in contact spring rates and setting.

The low temperature coefficient tuning fork forms a resonant element in a closed loop transistorised amplifier. The amplifier is coupled to the tuning fork by a magnetic sensing coil and a magnetic drive coil.

Oscillations are started by means of a striking knob and thereafter maintained by the transistor amplifier. The output from the fork is in the form of a narrow triangular pulse once every cycle and is suitable for direct driving of stroboscopic tubes or as a synchronising signal for an oscillator which drives a synchronous motor. The circuitry of the tuning fork is transistorised throughout.

Accuracy: At 20°C the frequency of oscillation of the fork is $50 \pm (5 \times 10^{-3})$ cycles per second.

Output: The amplitude of the pulse is not less than 175 volts positive.

Input: The tuning fork operates from supply of 235 V ± 5%, 50 cycles. When it is switched on an indication light is lit.

Dimensions: $4\frac{1}{2} \times 10 \times 5\frac{1}{2}$ in.

Weight: 12 lb.

Circle **64** *for further details.*

Constant Weight Feeder

THE new Sinex Minor constant weight feeder offers a solution to the problem of an accurately controlled low output rate such as is frequently encountered in the chemical and other allied industries. It is designed to feed accurately any dry powder or granular material at an output rate of between 2 - 15 kg/h, with an accuracy of ± 1%.

The constant weight feeder consists of a small buffer hopper, vibratory feeder, weighed belt assembly incorporating a high speed balance together with the necessary control circuits, all housed in a single cabinet measuring less than 2 ft 8 in. cube. Since the belt is driven at constant speed any error indicated by the balance pointer is directly proportional to the output rate. Special contactless detectors are incorporated inside the balance to convert the pointer position into a suitable electrical signal and this signal is used to vary the output of the vibratory feeder via a thyratron valve and thus maintain a constant output feed rate.

The design is such as to allow for electrical interlocking with existing units and remote starting can easily be incorporated.

Circle **65** *for further details.*

Differential Cathode Ray Polarograph

THE Nashton differential cathode ray polarograph is a new high sensitivity instrument, devised and manufactured for use in many different forms of nuclear, medical, industrial and agricultural research. It is a production version of the equipment developed by H. M. Davis, H. I. Shalgosky and J. E. Seaborn, of the U.K. Atomic Energy Authority.

It has two indentical polarographic cells, which can be used separately or together. There are synchronising devices which ensure that both mercury-drop cathodes grow and fall simultaneously in twin cell operation. The two cells are housed in an airtight Perspex chamber, through which a flow of nitrogen is maintained. Nitrogen is also bubbled through the cells themselves before a determination is carried out, to eliminate effects due to dissolved oxygen in the solution.

The cells are fed through tap funnels and exhausted by vacuum suction, so that the working solutions can be removed or replenished without opening the chamber. Mercury can be drained from the cells by means of a separate tap.

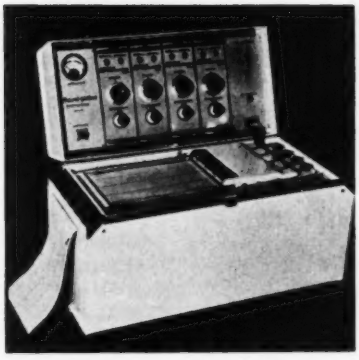
This polaragraph is claimed to have a greater maximum resolving power than the normal cathode ray polarograph and to be between 7 and 10 times more sensitive in single cell operation. This is mainly due to the provision of " base line slope compensation ", whereby residual currents due to earlier reductions can be cancelled by the application of a small opposing current (maximum 0·1 milliamperes).

Using two cells, the D.C.R.P. is between 1 and 05 times more sensitive in derivative operation, depending on the resolution required, and 10-11 times more sensitive by the subtractive method; specially purified reagents are not required. In comparative polarography, determinations with a coefficient of variation better than 0·2% are possible. Peak heights can be measured over a maximum height of 100 mm to an accuracy of ± 0·5%.

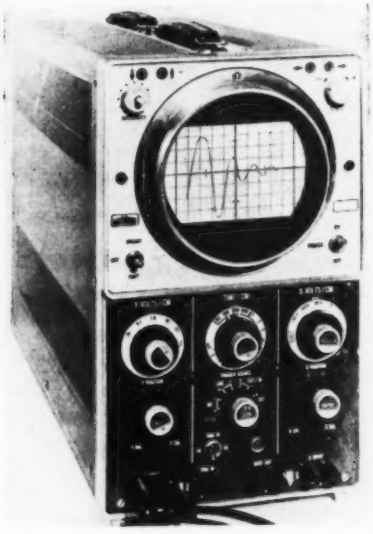
In derivative operation the trace approximates to the first algebraic derivative of the current wave form for a single cell. Time constant networks of 0·01 or 0·03 seconds can be used to obtain derivative displays of the waveforms produced in single cell, subtractive or comparative operation, and second derivative traces in derivative operation. The shorter time constant is used where the highest resolving power is required and the peak heights obtained with maximum sensitivity are about 8 times greater than with the ordinary cathode ray polarograph. With the longer time constant they are approximately 20 times greater.

Metallic impurities in foodstuffs can be indentified at concentrations down to 0·02 parts per million. The instrument can be used for soil analysis, for studying

Differential cathode ray polarograph



Galileo 4-channel industrial recorder



Dumont storage oscilloscope ▶

the oxygen content of blood plasma or for investigating respiration and photosynthesis in living cells. Many kinds of inorganic and some organic analyses can also be carried out with greater accuracy than was formerly possible.

Circle **66** *for further details.*

Direct Writing Recorders

A NEW range of industrial direct writing recorders manufactured by Officine Galileo of Florence, for the permanent recording of a wide range of phenomena encountered by engineers, physicists, chemists and scientists generally, is now available in the United Kingdom through Leland Instruments Ltd.

These direct writing instruments, using interchangeable pre-amplifiers, represent a new concept in the techniques of industrial and laboratory recording. The study of phenomena of any nature can be performed with a single recorder by making a suitable selection of interchangeable pre-amplifier units.

The recorders, employing ink pen or hot stylus, can be supplied in several standard models—portable single pen, two or four pen instruments or rack-mounted on wheels and having 2, 4, 6, 8, 16 or 32 channels, thus permitting the simultaneous recording of an equivalent number of phenomena.

The pre-amplifier units, containing voltage amplifying stages, their controls and (if required) filters, incorporate printed circuits and transistors. They are sturdy and compact and may be inserted and removed quickly from the recording unit. A wide range of pre-amplifiers, suitable for any technical measurement, is available.

The hot stylus record has the advantage of being in Cartesian co-ordinates permitting easy interpretation and correlation of multi-channel recording. For low speed phenomena this system affords high resolution and a well defined trace. The multi-channel instruments may have a built-in photographic recorder allowing the examination of phenomena whose higher frequency components (200-800 cycles) would not be reproduced by direct-writing pens.

The Galileo recorders operate from a power supply of 110 to 220 volts, 50 cycles, have a response time of 0·01 second and paper speeds varying from 2·5 mm per second to 100 mm per second. If required, other paper speeds and a time-marker may be included.

Circle **67** *for further details.*

Dumont Storagescope

AVELEY ELECTRIC LTD. have introduced into the U.K. a new Dumont storage oscilloscope Type 430.

This oscilloscope is a compact one piece unit with identical X-Y amplifiers, of high sensitivity and a frequency range from d.c. to 10 kc/s.

Generally speaking, the instrument can be classified as an X-Y plotter with a 10 kc/s bandwidth. Its larger useable screen ensures greater detail and accuracy and special circuitry protects the cathode ray tube and virtually eliminates all chances of screen damage.

There is a wide selection of automatic sweep speeds of driven or single sweep. Single sweep is armed manually enabling transients to trigger the sweep. The study of these transients is aided further by other panel buttons which activate "extra brightness" curcuitry for short time brilliance. The erase time is 15 seconds with repeat storage cycles every 60 seconds and storage time can be from seconds to days.

The sensitivity of the X and Y amplifier are 10 mV/cm to 100 V/cm in switched steps, with single or balanced inputs. In the balanced condition, common mode rejection exceeds 40 dB. Amplifier phase shift is less than $\pm$ 1° from d.c. to 3 kc/s.

An internal $\pm$ 1% calibrator is available to calibrate the X and Y amplifiers.

The Dumont oscilloscope Type 430 is particularly suited to applications such as electro-chemical, electro-medical, electro-biological, computer read out and vibration testing.

Circle **68** *for further details.*

A Digital System for Process Instruments

ROTAX LTD., have developed a system for the remote indication and recording of data from conventional process measuring instruments. The basis of the system is analogue to digital conversion at the instrument shaft without appreciable additional loading of the movement. This simple converter is inexpensive and can be fitted to pressure gauges and other instruments, converting them to digital transmitters.

Transmission of data readings can be automatic or on manual demand, either single or as part of a complete data logging system. Digital signals and control call-up signals are transmitted along two wires only and the power used has been kept low enough to satisfy Post-Office line requirements.

Circle **69** *for further details.*

Electric Valve Actuators

ROBUSTNESS and an ability to withstand mishandling are the features of a new range of electric valve actuators introduced by Rotax Ltd. The actuators have been designed primarily for uses with wedge gate valves over the range from 6 inches to 72 inches stroke, having a thrust rating between 2,000 lb and 50,000 lb. In all models the thrust value is adjustable by means of a torque limiting device. There is a choice of output speeds in the range 18-60 rev/min.

Any valve can be operated manually at any time with complete safety to the operator. In addition in the larger models, either the motor operation or the manual operation can be arranged to take precedence over the other.

To facilitate the opening of a valve which has jammed shut the opening is initiated by an automatic hammer-blow to the valve spindle nut. Each valve has a position indicator and provision has been made for remote indication if required.

Flameproof and non-flameproof versions are available.

Model	R.C.A. 0801	R.C.A. 1001	R.C.A. 1002
Thrust Rating	8,000 lb	50,000 lb	50,000 lb
Max. Spindle Diameter	1½ inches	3 inches	3 inches
Max. Stroke	18 inches	72 inches	72 inches
Motor (400/440 V, 3-phase squirrel-cage)	½ hp motor	3 hp	3 hp

Circle **70** *for further details.*

Revolution Counter

THE "Albion" Type 1-23 revolution counter has a separate detachable gearbox, supplied right or left hand, with 4 or 5 figures and reset lever. A variety of ratios can be supplied to suit individual requirements.

Driving shafts may be at sides, front, base or rear.

The unit can be supplied with or without gearbox, it includes patented roller reset cam mechanism and is self lubricating.

It is now available from B. & F. Carter & Co. Ltd.

Circle **71** *for further details.*

Solid Tantalum Capacitors

RCA have introduced a miniature polarised, solid-tantalum electrolytic capacitors in an exceptionally small package. Known as the CT series, these capacitors are of a rectangular configuration measuring 0·27 in. wide, 0·285 in. long and 0·06 in. thick, and are designed to operate over the ambient temperature range from − 80° to + 125°C. The CT series are available in a wide range of capacitance values and voltage rating and have tolerences of 20%, or 5%.

CT - series capacitors are precision moulded in a special high quality insulating material which provides high mechanical strength and protection to withstand adverse environmental conditions, and eliminates the need for separate insulating sleeves. These capacitors are provided with two parallel, solder - coated leads spaced 0·2 in. apart to facilitate use in printed circuit boards using 0·025 in. and 0·1 in. grid spacings.

Circle **72** *for further details.*

High-speed Flight Simulator

A PILOT's ability to control a high performance aircraft in bad flying conditions can be tested by a new machine built for the Ministry of Aviation by the Precision Engineering Division of Short Brothers & Harland Ltd.

The machine, which will shortly be delivered to the Royal Aircraft Establishment, Bedford, is known as a rocking cockpit or, in full, a flight simulator moving cockpit mechanism. It can move a complete aircraft cockpit just as it would move during high speed flight. For this reason it is considered a marked advance on conventional trainers which, being stationary, cannot give a pilot the sensation of being "thrown around".

The simulator consists of a heavy steel structure surmounted by a wide movable arm to which an aircraft cockpit will be attached. The arm, powered by two electro-hydraulic servos, can swing the cockpit up and down or tilt it from side to side—movements which correspond to pitch and roll in an aircraft. The cockpit will be equipped with standard flying controls which will enable the pilot to govern its attitude in the pitch and roll planes and thus "fly" the simulator.

In simulated "still air" conditions the cockpit will be completely under the control of the pilot, but to test his reactions in unfavourable flying conditions a specially built analogue computer will feed disturbances into the control system. The computer can be programmed to feed in any desired pattern of disturbances, causing the cockpit to move as it would in an aircraft flying through cross-winds, gusts, and turbulence. To keep the cockpit under control the pilot will then have to counteract the movements initiated by the computer. In other words he will "fly" through these adverse conditions exactly as though he were in a real aircraft.

In the roll plane the cockpit can tilt to 15° from horizontal on each side at a maximum rate of 45° per second. In pitch the limits are 20° above horizontal to 10° below, at maximum rate of 25° per second. As the pilot is situated at the end of a swinging arm and is approximately six feet away from the pitch axis he can be swung through a large arc.

Because the rates of turn are high—the cockpit can go from horizontal to maximum tilt in any direction in less than one second—safety devices have been incorporated in the simulator's design. Special damping devices at the limits of the system's movement will

overrule the pilot's commands should he make an error causing the cockpit to try to go beyond the maximum tilt. The safety mechanisms will also come into operation in the case of a runaway in the control circuits. Their function is to slow the system down when it nears maximum tilt, thus avoiding the excessive strain to both unit and pilot which would be the result of hitting the stops at speed.

A cockpit unit will be supplied by the R.A.E. and fitted to the simulator after delivery. But for the purpose of testing the machine, Shorts have fitted a temporary pilot's seat and controls, with extra weights to represent the weight of the cockpit. The estimated weight of pilot and cockpit is over 700 lb but the pitch servo motor is relieved of the overhanging moment loads by a balance ram acting on the underside of the swinging arm.

Circle **73** *for further details.*

Cable Connectors

THE "ConheX" crimp-type connectors recently introduced by Sealectro Corp., is said to reduce assembly time by approximately 66%, permitting the assembly of three cable connectors in the time taken for one assembled by the conventional manner. The crimp type employs a sleeve which is slipped over the cable. The cable is then properly trimmed, the centre conductor tinned and inserted into the connector body, the sleeve is slipped up against the connector body, and then crimped with a hand or power tool of the proper design, after which the contact is soldered to the centre conductor. The finished assembly is so designed that impedance value is maintained because there is no dielectric collapse resulting from the crimping operation.

Circle **74** *for further details.*

Floatless Liquid Level Control

A NEW range of Lectralevel control units and electrodes is now available from Londex Ltd. Lectralevels operate by the conduction of a small current of low voltage through the liquid. As alternating current is employed no electrolysis can take place. By utilising electro-magnetic relays no components liable to fail are used in the control unit.

The output contacts will control a pump motor, valves, alarm circuits, etc., depending on the application.

There are no moving parts in contact with the liquid such as floats, chains or linkages; the Lectralevel equipment therefore will operate reliably without maintenance.

The Lectralevel units LL/U1 and LL/U2 are suitable for operation with most liquids. A Lectralevel of higher sensitivity is also manufactured for use with liquids of low conductivity such as distilled water and pure condensate.

The LL/U1 unit is truly universal in that it can be arranged as a control for either emptying or filling, as a high or low level cut-out or alarm device. A sensitivity selector is incorporated making the one unit suitable for use with a variety of liquids having a wide range of conductivity. Sewage, acids, chemical solutions, milk, polluted or clean water can all be controlled with the same unit.

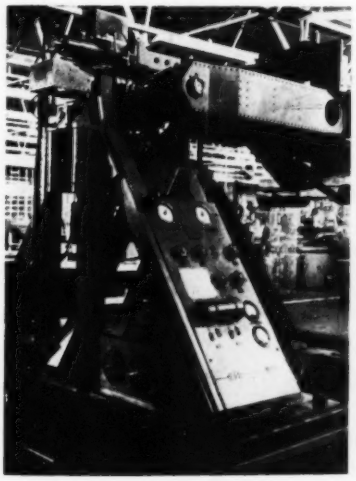
A built-in voltage selector enables this unit to be used on all standard supplies of 200/250 V a.c. and 400/440 V a.c.

The single-pole changeover output contacts are solid silver and rated up to 2 A, 440 V a.c. (4 A, 250 V a.c.).

The Type LL/U2 is similar to the LL/U1 but has certain features which makes it more suitable for arduous industrial applications or where, in addition to pump control, extra circuits must be controlled. The equipment is housed in a robust cast casing which is weatherproof. An operation selector is incorporated giving "fail safe" characteristics under all conditions. To give visual indication of the position of the output contacts, a neon signal lamp is fitted to the front of the unit. The fully universal LL/U2 can be connected either for emptying or filling control, as a high or low level cut-out or alarm unit.

When being used for pump control the additional contacts which are provided can be used for signalling circuits.

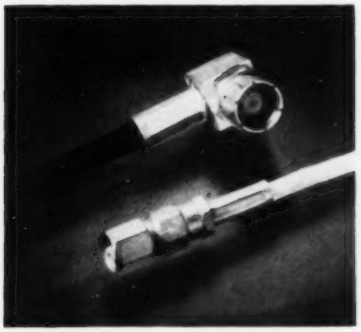
Circle **75** *for further details*

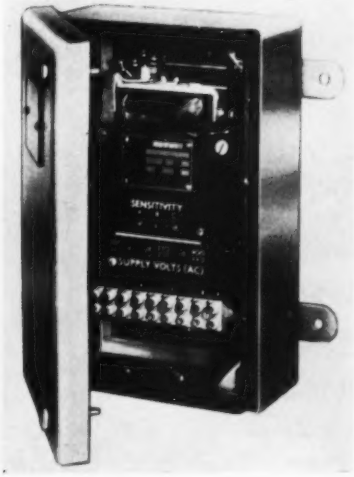


◀ *Rocking cockpit simulator*

Lectralevel Type LL/U1 ▶

Cable connectors





Circle 359 for further information

MS FLUID FACTS

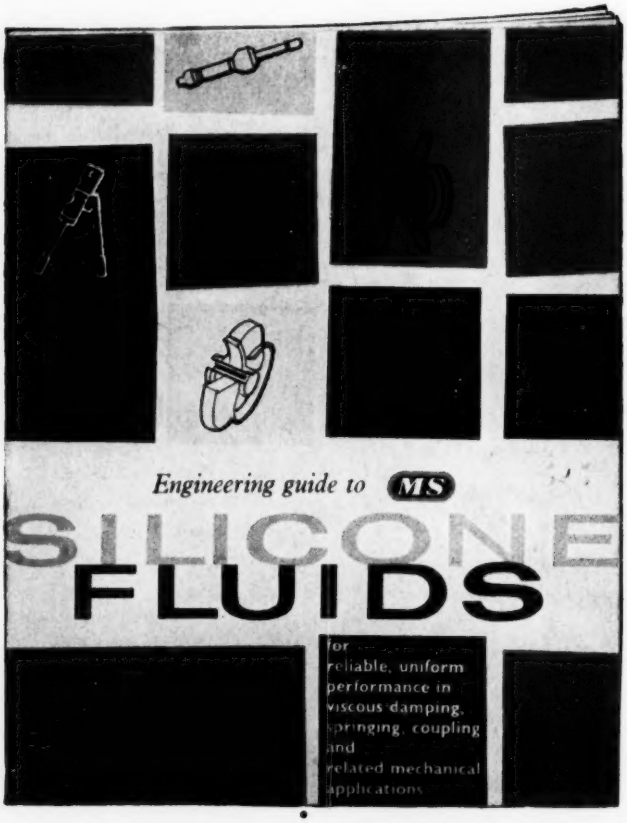
How much do you know about SILICONE FLUIDS

Did you realise that they have:

- *Exceptional thermal stability*
- *Excellent viscosity temperature characteristics*
- *Extreme resistance to oxidation and shear breakdown*
- *Low volatility*
- *High flash points*

No? Well why not find out more about these versatile fluids and the way that they are already being used by industry. Our publication 'Engineering Guide to M S Silicone Fluids' (G 11) sets out numerous application examples and gives further particulars of the properties—why not write for a copy today—now!

If your requirement is more for silicone lubricants and greases then 'Silicone Lubricating Fluids & Greases' (G 14) *is the publication for you.*


Engineering guide to MS
SILICONE
FLUIDS
for reliable, uniform performance in viscous damping, springing, coupling and related mechanical applications

MS

MIDLAND SILICONES LTD

(Associated with Albright & Wilson Ltd. and Dow Corning Corporation)

***first** in British Silicones*

68 Knightsbridge · London · SW1 · Telephone Knightsbridge 7801

Area Sales offices: Birmingham, Glasgow, Leeds, London, Manchester

Agents in many countries

Please send me a copy of your illustrated booklet:

'Engineering Guide to MS Silicone Fluids' ☐

'Silicone Lubricating Fluids & Greases' ☐

Name.....

Company.....

Address.....

MSF8

NEWS OF THE INDUSTRY

POLYPENCO LTD. have installed **ultrasonic testing equipment** for routine production inspection at their Welwyn Garden City factory.

Designed to improve methods of quality control by rapid detection of possible defects in rod, tubes, sheet, discs, etc., which are subsequently machined, the process is now being applied to all stock shapes manufactured by Polypenco Ltd.

The ultrasonic testing equipment is a self-contained unit incorporating an oscilloscope and operated on the principle of the dampening effect of voids or flaws on ultrasonic vibrations passed through the object under examination.

The unit is equipped for both reflection and through transmission work and any flaw is revealed on the oscilloscope as a variation in degree or position of pulse peaks.

PART of the **automatic check-out equipment** Dattico Mk III produced by the Nortronics Division of the Northrop Corporation is made by Solartron Inc., California, a subsidiary company of Solartron Electronic Group Ltd.

Solartron Inc. re-engineered the British dynamic analysis equipment to conform with the exacting U.S.A. Services Specification; this equipment is now included as standard in the highly complex system used in the launching of the Polaris missile. Picture illustrates Dattico Mk. III equipment being checked, which contains the Solartron equipment referred to.

THE University of Texas Tumour Institute is using an **IBM 305 Ramac computer** to calculate the precise radium dosage for each radium implant given as a standard part of radio therapy. Previously doctors have estimated dosage with attendant dangers of too little or too great radiation. RAMAC calculates the precise dosage in three hours against four weeks by manual methods. An IBM 1620 computer, later to be used, will make this calculation in five minutes.

AN **IBM 7090 data processing system** has been installed at the Australian Government's Weapons Research Establishment in Salisbury, South Australia. The 7090 will be used to analyse flight test data from the Woomera Rocket Range and enable performance evaluation reports to be rapidly available to research scientists in the United Kingdom and Australia.

CROMPTON PARKINSON **panel-mounting moving-coil and moving-iron instruments,** the first of their size and type to pass the Admiralty Shock Test as applied to instruments, have been approved for use in fighting ships.

These Admiralty pattern ammeters and voltmeters have 240° circular scales and square or round bezels. Square bezel instruments have 2 in. dials with scales 3⅛ in. long; round bezel instruments have 2½ in. dials with scales 4¼ in. long. The die-cast metal cases are nitrogen-filled and sealed and dimensions conform with Ministry of Defence Specification No. DEF-62.

THE **IBM 705 computer** recently installed by the Royal Army Pay Corps at Worthy Down, in Hampshire, for processing the whole of the Army payroll, will be used to edit, analyse and arrange information from the United Kingdom Census schedules into statistical reports in little more than half the time which has been required in the past.

The first report, on numbers of population, was produced in May and the work will be completed within three years, instead of the six or seven years formerly needed for the complete processing of the National Census.

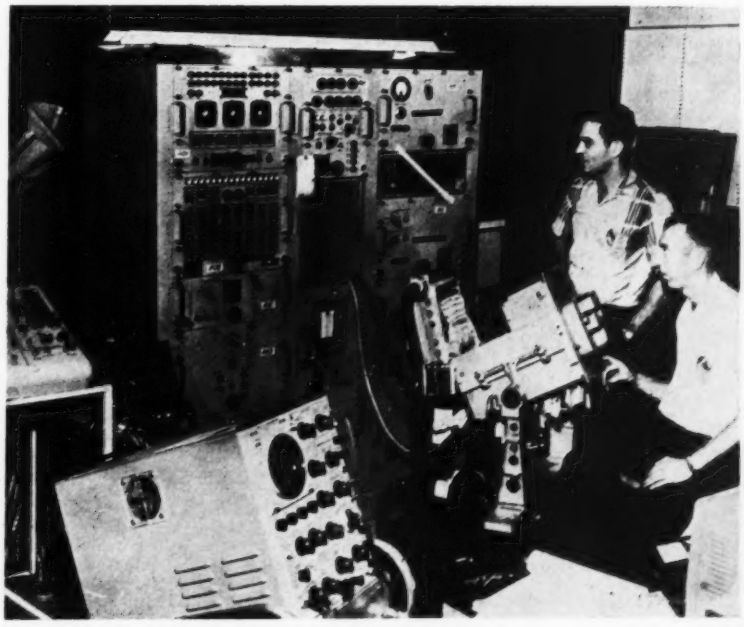
THE first overseas demonstration of the **photographic flight analyser** available from the Industrial Products Division of Fairchild Camera and Instrument Corporation, of New York, was held at Cranfield Aerodrome, 40 miles north-west of London, recently. Aveley Electric Ltd. is representing Fairchild for the photographic flight analyser in England.

The photographic flight analyser is a precision tracing device operated manually by one person which will accurately record the space trajectory of a moving object on film. Its advantages include the ability to track moving objects at high azimuth rates, a low cost for reducing the data obtained from the tests, and portable equipment which does not sacrifice accuracy.

THE textile machinery industry, the Board of Trade and the Department of Scientific and Industrial Research are to carry out a study of research and development in the field of **textile machinery.**

This is one of a series of such studies of important industries in the U.K. which the Council for Scientific and Industrial Research has asked its economics committee to carry out. The purpose of these studies, which are made with the

Dattico Mk. III



collaboration of the industries concerned, is to help the council to allocate the resources for research and development, which the Government puts at their disposal, so as to achieve the maximum benefit to the national economy.

EMIDEC 1,100 computer installed by EMI Electronics Ltd. at EMI House, Manchester Square, London, W.1., will have three purposes.

Its main task will be the operation of a fully integrated data processing system for EMI Records, Ltd. including sales invoicing and monthly statements, sales statistics, stock control, production control, copyright and artistes' royalties.

EMI Group's payroll for 14,000 employees will also be prepared by the computer, which will print out the payroll slips or envelopes and produce a labour cost analysis.

Secondly the EMIDEC will test programmes which have been prepared for eventual use on computers to be installed in other organisations' premises and those customers' computing staff will be trained in the operation of the machine, gaining the benefit of the experience of EMI's own staff in operating the EMIDEC on a working basis.

Thirdly, computing time will be sold to other companies which can occasionally use the facilities of electronic data processing but do not have a sufficient volume of work to justify outright purchase of a computer.

Being publicly exhibited for the first time at their new permanent showroom was the latest version of EMI's studio image orthicon TV camera. A microwave link of the type used in the Eurovision network was also on show.

There was a display of EMI's special valves and tubes used in applications as varied as sending back information from outer space and automatically switching on street lights at dusk.

Working demonstrations were given of stroboscopes "freezing" a rotating mechanism in motion, the latest transistorised version of a portable professional tape recorder, dynamic balancing machines and oscilloscopes.

THE increasing demand for Crompton Parkinson **electrical tachometers** has enabled the generator used with this system to be redesigned for large-scale production by the most advanced mechanised means. The substantial saving in costs thus achieved is reflected in a reduction in the price of the generator of approximately 30%.

COMPANIES

INCREASING component sales and the need for a more rapid means of supplying customers with technical and engineering information on such a wide variety of products have made it necessary for **Aveley Electric Ltd.** to form a separate division. This division will be designated the Components Division and will be self administrating and responsible for the sales and after sales service of the following items:

Resistors	Dezifix Connectors
Capacitors	Crystals
Capacitance Standards	Crystal Filters
Oscilloscope Cameras	Crystal Ovens
Photo Multipliers	Wide Band Amplifiers
Storage Cathode Ray Tubes	Transistorised Power Supplies
Cathode Ray Tubes	Toroidal Mains Transformers
Electrical Measuring and Control Instruments	Toroidal Output Transformers
Panel Meters	Aerials (Industrial and Commercial)
Portable Test Sets	

British Space Development Co. Ltd. announce that the following companies have become founder members:

Associated Electrical Industries Ltd.
Associated Television Ltd.
British Insulated Callender's Cables Ltd.
Decca Radar Ltd.
Hawker Siddeley Aviation Ltd.
The Plessey Co. Ltd.
Pye Ltd.
Rank Television and General Trust Ltd.
Rolls-Royce Ltd.

Sir Robert Renwick, Bt., K.B.E., has been appointed chairman and the following have been elected to the Board:

Mr. J. R. Brinkley, A.I.E.E., M.Brit.I.R.E.
Group Capt. E. Fennessy, C.B.E., B.Sc., M.I.E.E.
Mr. G. C. I. Gardiner, C.B.E., F.R.Ae.S., M.I.Mech.E.
Mr. A. A. Rubbra, C.B.E., B.Sc., F.R.Ae.S., M.I.Mech.E.
Group Capt. D. Saward, O.B.E.

A technical committee has been set up under the chairmanship of Mr. G. K. C. Pardoe, B.Sc.(Eng)., D.L.C., A.F.R.Ae.S. Members of the technical committee are:

D. E. Burchett	— A.E.I.
A. V. Cleaver, F.R.Ae.S.	— Rolls-Royce
J. M. C. Dukes, M.A., D.I.C., A.M.I.E.E.	— Plessey
W. F. Hilton, D.Sc., Ph.D., A.R.C.S., D.I.C., F.R.Ae.S., A.F.I.Ae.S.	— Hawker Siddeley
W. M. Lloyd, B.Sc., A.R.C.S.	— Rank
L. F. Mathews, M.Brit.I.R.E.	— A.T.V.
K. Milne, Ph.D.(Eng)., B.Sc.(Eng).	— Decca Radar
T. P. Blott	— Pye
G. A. Dodd, A.M.I.E.E.	— B.I.C.C.

The directors of British Space Development Co. Ltd. intend to examine ways and means by which this country shall assume a significant role in space technology. They consider that Britain has the talent and resources necessary to play an important part in the future utilisation of space, particularly for commercial purposes.

The task of the technical committee will be to examine and prepare plans designed to achieve British participation with the minimum of delay. Its first priority will be to submit proposals for the use of space for communications.

Elga Products Ltd. mobile demonstration unit is touring this country and Europe, showing Elgastat de-ionisers and conductivity meters

As a result of the acquisition last year of Morphy-Richards Limited, the United Kingdom domestic appliance activities of the **E.M.I. Group** have been reorganised. A single division has now been formed under Mr. W. Roxburgh, the managing director of Morphy-Richards Ltd.

The marketing and distribution of hi-fi components is being undertaken by an associate of E.M.I., The Clarke & Smith Manufacturing Co. Ltd. That company has also acquired the business of Home Maintenance Ltd., the service company of E.M.I.

The marketing of sound equipment (stereo, record reproducers, and tape recorders) will continue, as hitherto, to be done by The Gramophone Co. Ltd., under its managing director, Major J. F. E. Clarke.

The Recording and Relay Division of The Gramophone Co. Ltd. has now been transferred to E.M.I. Electronics Ltd.

Elliott-Automation Ltd. has formed a new subsidiary company, A. B. Elliott-Automation in Sweden.

Mr. J. W. Grant, manager of the Industrial Weighing Division of Elliott Brothers (London) Ltd. has recently gone to Stockholm to establish the new company and to consolidate the Groups existing interests there. He will have the assistance of A. B. Termostatik, the Swedish subsidiary of the Rheostatic Co. Ltd., another member company of the E-A Group.

As foreshadowed in last summer's announcement by the chairman, **The Morgan Crucible Company Ltd.** ceased to trade on 3rd April and became a holding company. From that date, its responsibilities for production, trading, research and development have been assumed by the following five new wholly owned subsidiaries:

Morganite Carbon Ltd. Battersea, S.W.11. Managing Director: C. S. Harris*	Carbon Products (Electrical) Carbon Products (Mechanical) Sintered Bearings (RESERVOIL)
Morganite Crucible Ltd. Norton, Worcester. Managing Director: D. S. S. Thynne	Crucibles (SUPER) Crucibles (SUPEX) Furnaces and Foundry Accessories
Morganite Electroheat Ltd. Wandsworth S.W.18. Managing Director: I. Weston Smith*	Furnace Elements (CRUSILITE)
Morganite Research and Development Ltd. Battersea, S.W.11. Managing Director: J. Walker*	Research and Development
Morganite Exports Ltd. Battersea, S.W.11. Managing Director: J. H. Baumann	Export

Other U.K. subsidiaries in the Morgan Crucible Group (of which the Morgan Crucible Co., Ltd. is the Holding Company) are:

Morgan Refractories Ltd.
Morganite Resistors Ltd.
Ship Carbon Co. of Great Britain Ltd.
Graphite Products Ltd.
Morgan Components Ltd.
Morgan-Mintex Ltd.
(* Denotes directors of the Holding Company.)

Lea Bridge Cabinet Works Ltd., a member of the A. C. Cossor Group, has acquired the extensive modern factory, plant and business, of Harwood Cabinets Ltd., Romford, Essex, from Regentone Products Ltd.

The factory is equipped with the most up-to-date veneering and woodworking machinery, together with radio frequency equipment for assembly, and a modern finishing shop capable of finishing cabinets in polyester, melamine, or cellulose. Together with precision instrument case manufacturing, manufacture of woodwork for the building, flooring, domestic appliances and furniture industries has now begun.

Mr. T. W. Cass, managing director of Lea Bridge Cabinet Works Ltd., will be in charge of the company's enlarged activities at Romford. He will have the assistance of his colleague, Mr. A. E. Ager and Mr. John Bowes. Mr. Bowes was works director of Harwood Cabinets Ltd.

THE **Ekco Group** has formed two new companies: Ekco Radio and Television Ltd., to control the marketing of all Ekco television and radio receivers, car radio and allied products: and Ekco Heating and Electrical Ltd., to be responsible for the marketing of the wide range of Ekco heating equipment and electric blankets.

Mr. R. Wrathall, formerly Radio and Television sales manager of E. K. Cole Ltd., is director and general manager of Ekco Radio and Television Ltd., while Mr. C. B. Cleland, formerly general manager of E. K. Cole's Heating Division is director and general manager of Ekco Heating and Electrical Ltd.

The full list of directors is as follows:
Ekco Radio and Television Ltd. Mr. W. M. York, chairman; Mr. R. Wrathall, director and general manager; Mr. E. B. Willcocks; Mr. N. T. Atkinson; Mr. A. C. Segger.
Ekco Heating and Electrical Ltd. Mr. W. M. York, chairman; Mr. C. B. Cleland, director and general manager; Mr. A. J. Brunker; Mr. S. A. Clodd; Mr. E. Walley.

Dewrance & Co. Ltd. announce the formation of the Dewrance Metals Division.

This will consist of the Foundry at Hillington and the Special Alloys Division in London.

The new division will have its own board of management and will be responsible for the production and sales of high quality non-ferrous castings, nickel alloy castings, stainless stee castings, "Endewrance" hardfacing and high temperature brazing alloys. The production executive is Mr. J. B. Morton, situated at Hillington, and the sales and technical executive is Mr. E. Wallace, situated in London.

The Plessey Co. Ltd. has purchased the freehold of its plants at New Lane, Havant, Hampshire and Wood Burcote Way, Towcester, Northants. The purchase price of over £500,000 includes both the land and buildings.

Both plants are operated by the Components Group of the company, and are used for the manufacture of a wide range of radio and electronic components.

Evans Electroselenium Ltd., manufacturers of "EEL" photo-electric instruments now have their own sales and service organisations in Scotland. Sales are in the hands of Electricals (Laboratory) Ltd., of 3a St. Vincent Street, Edinburgh, 1, who are representing "EEL" for the whole of the country. Servicing is in the hands of Scientific Instruments (Glasgow) Ltd., Landsdowne House, 154-6 Grovepark Street, Glasgow.

IN order to cut down delivery times, to provide greater capacity and to improve laboratory facilities, **Rivlin Instruments Ltd.** have trebled the area of their factory, at the Yorktown Industrial Estate, Camberley, Surrey, shown in the accompanying photograph.

Already new machines and additional operatives have been installed to boost the present production programme, and Rivlin have been able to maintain production during the transition period.

Pyrotenax Ltd. have recently celebrated their Silver Jubilee. Twenty-five years ago, Pyrotenax Ltd. founded a new industry in the United Kingdom with the introduction of mineral insulated cable. This cable which was completely fire-resistant and non-fire causing met a long felt want for a really safe wiring system.

Starting with 12 employees in 1936 the total personnel today is well over 1,000 with factories in Australia and Canada. Within the same period the range of cables has risen from 25 sizes and types to 200.

IPSEN INDUSTRIES INC., of Rockford, Illinois, in association with Ipsen Industries International G.m.b.H., of Kleve, West Germany, manufacturers of atmosphere and vacuum automatic heat treating equipment and associated plant, have formed a British company, **Ipsen Industries Ltd.,** 53 Victoria Road, Surbiton, Surrey, to facilitate further expansion of sales and service in Great Britain. Several Ipsen installations are already in operation in this country and more are in hand for the future.

FOLLOWING the recent merging of Parkinson Cowan Instruments and Measurement Ltd. to form the new operating division **Parkinson Cowan Measurement,** it is now announced that PCM are to intensify their service to the water industry by increasing the number of sales engineers responsible for the sale of water meters and telemetering equipment.

The reorganised Parkinson Cowan Measurement representation is now as follows: Mr. J. Cockayne operating from Glasgow, will serve Scotland; Mr. C. Grosset the North; Mr. Emrys-Roberts will cover Wales, South-West and Southern England; Mr. S. Armitage will be responsible for the Midlands and Mr. A. L. West will call on water engineers in greater London, East Anglia and South-East England.

Welwyn Electric Ltd. and **Overseas Corporation (Australia) Ltd.** have formed a jointly owned subsidiary:
Welwyn Electric (Aust) Pty. Ltd.
P.O. Box 62, North Essendon,
Melbourne, Victoria,
Australia.
The new company will have its headquarters in Melbourne and offices in Sydney and Adelaide. It will handle all products manufactured by Welwyn Electric in Great Britain.

Rivlin factory at Yorktown Industrial Estate, Camberley

New 10,000 sq. ft extension to EMI Electronics Ltd's valve factory at Ruislip, Middlesex, was built to cope with the rapidly increasing demand, both in the United Kingdom and overseas, for EMI photo-multipliers, TV camera tubes and klystrons. Interesting feature is the use of under-floor service ducts to eliminate the need for down-drops and to facilitate layout changes.

THE NEWS OF THE WORLD ORGANISATION LTD. has agreed to purchase the whole of the issued share capital of **Vactric (Control Equipment) Ltd.** and **Vactric (Precision Tools) Ltd.** from the Receiver of Vactric Ltd. (in liquidation).

New boards of the above companies will be formed with Sir William Carr as chairman, and the present managing director, Mr. T. W. Roberts, will continue in that capacity. The boards will also include Mr. G. Reed, Mr. R. J. Lawson and Mr. G. E. Edwards, the present executive directors.

The management of the two companies therefore remains unchanged.

OWING to a continued increase in business, **Taylor Controls Ltd.** announce the opening of a London office at:

Holborn House, 113 High Holborn, W.C.1. (Telephone: HOLborn 0921).

The head office and works are still at Hale End Road, Walthamstow, E.17.

Racal Engineering Ltd. and **Racal Instruments Ltd.** of Bracknell, announce that they are now on Telex service. Their number is 84166.

As a result of severe damage by fire to the Servicing Department at West Norwood, London, S.E.27, **Cossor Radar & Electronics Ltd.** have, as from 24th April, wholly transferred the operations of the Servicing Department to:

Edinburgh Place,
Temple Fields,
Harlow, Essex.
Telephone: Harlow 25537.

Coulter Electronics Ltd's. new address is:

2-4 Ashwell Street,
St. Albans, Hertfordshire.
Telephone: St. Albans 50828-9.

THE telephone number of **KABI (Electrical and Plastics) Ltd.** has been changed to Potters Bar 53444.

AGREEMENTS

THE directors of **Ultra Electric (Holdings) Ltd.** announce that an Agreement has been signed between **Ultra Electronics Ltd.** a subsidiary of Ultra Electric (Holdings) Ltd., and **Electronics Investment Management Corporation** of the United States of America.

Electronics Investment Management Corporation renders advisory and consulting services with respect to broad aspects of the electronics industry and has an association with many companies in the forefront of electronic technology in the United States and elsewhere. This Agreement provides for the interchange of information on the subjects of research, development, marketing and production of electronic equipment as well as other aspects in the electronics fields.

The directors of **Ultra Electric (Holdings) Ltd.** also announce that the company has entered into an agreement with **Electronics International Capital Ltd.** a company created by a Special Act of Parliament in Bermuda, whereby Electronics International Capital Ltd. has purchased from Ultra Electric (Holdings) Ltd. 40% of the shares of Ultra Electronics Ltd. for a sum of £800,000, and Electronics International Capital Ltd. has, in addition, agreed to make available five year loan facilities, bearing interest at the rate of 8% per annum, up to a maximum sum of £950,000.

Electronic Associates, announces the acquisition of Gorrell & Gorrell, an American firm that manufactures electro-mechanical devices for graphically recording the performance of industrial and business machines. All manufacturing facilities will be transferred to the West Long Branch plant of Electronic Associates and Dr. John Gorrell will manage the new line of products.

Gorrell & Gorrell has since 1931 marketed testing devices for use in biological laboratories at hospitals and universities. Its leading product is an instrument for recording the operating cycles of various production and business machines whose users, among other companies include Minneapolis-Honeywell Regulator, Sealright Co. and The Chase Manhattan Bank.

A LONG-TERM marketing and manufacturing agreement has been made between **International Computers and Tabulators Ltd.** and the **National Data Processing Corporation** of Dallas, Texas, U.S.A.

National Data Processing Corporation are manufacturers of document handling equipment, initially designed for bank automation, and optical character recognition equipment. By the agreement N.D.P. products will shortly be added to the I.C.T. range of equipment.

N.D.P.'s advanced products are complementary to I.C.T.'s punched card and electronic computer data processing equipment. Their introduction, as peripheral equipment, into appropriate data processing installations will greatly increase the scope for automated systems embracing electronic computer techniques.

The Plessey Co. Ltd. announces that following an agreement with **P. R. Mallory & Co. Inc.,** it is now manufacturing a range of solid electrolyte tantalum capacitors.

Chief features of the new capacitors are stability of capacitance with temperature, and the ability to operate at extremely low temperatures down to −80°C without loss of performance. The range of capacitance values available is 0·33 to 330 microfarad at d.c. working voltages of 35 volts to 6 volts.

Capacitance values up to 68 microfarads are available in a choice of working voltages up to a maximum of 35 V d.c.

These new capacitors supplement the established range of Plessey "Castanet" liquid electrolyte tantalum capacitors.

UNDER a new trade agreement between the **Marcel Dassault Aircraft Organisation** of France and the **Woden Transformer Co. Ltd.,** British designed electro-mechanical equipment is to be produced in France for the French company's aircraft and guided missile programme.

The agreement was signed in Paris by Mr. H. W. Mitchell, sales director of Woden Transformer Co. Ltd., and Mr. A Simon, commercial director of Generale Aeronautique Marcel Dassault, of France.

AGENTS

Aveley Electric Ltd. have been appointed sole U.K. Agents for the **Bach-Simpson** range of top-quality measuring, testing and control instruments. The Bach-Simpson Co. is a completely autonomous Canadian company producing the Simpson line of instruments in Canada entirely from its own resources, but sharing with the Simpson Electric Co. (Chicago) joint engineering and mutually advantageous development projects. The Bach-Simpson merchandising interests lie exclusively within Canada and the British Commonwealth.

The range of instruments which will be available to the British market will include multi-range test equipment, panel mounted control indicators, frequency and running time meters, components, educational instruments, radio and T.V. service equipment, laboratory apparatus, oscilloscopes and a wide range of portable instruments.

Aveley Electric Ltd. will immediately introduce the Simpson Type 260 and 270 test meters and the Bach-Simpson control indicator. Other instruments will be introduced at intervals.

Telemechanics Ltd. have recently been appointed sole agents for the sale of all electronic equipment of Deutscher Innen und Aussenhandel Elektrotechnik, Berlin, German Democratic Republic in the territories United Kingdom, Australia, Canada, New Zealand, Malayan Federation, Central African Federation of North and South Rhodesia and Nyasaland, Singapore and Portugal.

CONTRACTS

AN order has been received by **Honeywell Controls Ltd.** from the Continuous Casting Co. Ltd. for the complete instrumentation of a twin-strand continuous casting machine to be installed at the Abbey Works of the Steel Co. of Wales.

The machine will be instrumented by a new integrated two-wire electric system known as the ElectriK Tel-O-Set.

The system will control and record the flow of cooling water and lubricant at various points, and will monitor certain local flows; it will record and integrate the casting speed and record temperature rises across the moulds. Provision is made for a Honeywell data handling unit to be fitted later.

This order follows Honeywell's official introduction of the ElectriK Tel-O-Set system earlier this year. They have already received a £300,000 order incorporating the system for the 720-mile Northern India pipeline project.

A SMALL but powerful **electronic digital computer** has been ordered from **Ferranti Ltd.** (U.K.) by Imperial Chemical Industries of Australia and New Zealand Ltd. for use in their Central Research Laboratory in Melbourne. The computer is the **desk-sized Sirius.** The ICIANZ machine is expected to be installed during the first quarter of 1962. It will then be used for scientific and technical calculations and for the study of various problems connected with the chemical industry in Australia.

To handle the scale of problems the overall capacity of the computer has been substantially increased by additional storage and extra facilities for rapid input and output of information. This expanded installation will cost about £A.40,000 although the basic computer is considerably less.

Associated Electrical Industries Ltd. is being awarded another big order for generating plant at the Central Electricity Generating Board's West Thurrock power station. The order, which will be worth £2,300,000, will be for a 300 megawatt turbine-generator similar to two other machines already being made by AEI for this station. This brings the total value of the orders for West Thurrock to more than £7,000,000. The news follows an order for two 125 megawatt machines for South Africa.

Mullard Equipment Ltd. has been awarded the contract to supply a fully automatic telegraph switching system for the London Telegraph Centre of the Shell International Petroleum network.

The equipment, which will be installed in the new Shell Centre on the South Bank, will be capable of handling over 1,000 incoming messages per hour. Messages awaiting transmission over busy circuits will be stored electronically and automatically re-transmitted as soon as the wanted lines become free.

THE **General Electric Co. Ltd.** has received a repeat order, worth over £50,000, from the East Rand Engineering Co. of Johannesburg for equipment to be used in the conversion of a winder from steam to electric drive. As in the case of the previous order this converted winder will be installed underground at the Withok mine of the S.A. Lands and Exploration Co. Ltd., ("Sallies") of the Anglo-American Corporation Ltd.

BLACKPOOL CORPORATION, current users' of I.C.T. 36-column punched card data-processing equipment, have authorised the Borough Treasurer to place an order, with **International Computers and Tabulators Ltd.** worth £40,000 for new 40-column punched card machines.

The machines, including three tabulators and an electronic calculator are to be delivered in 1962/3 and operations are to begin with the new financial year (April, 1962).

SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD. has ordered a further 24 module EMIAC II analogue computer for its Coventry factory, from **E.M.I. Electronics Ltd.** making 48 modules in all, with the installation supplied in 1959.

This will be used for guided weapon work. The computer is capable of studying the performance of complete guided weapon and aircraft systems before they leave the drawing board.

EXPORTS

CHANGES in the B.S.I./C.S.A. agency organisation effected recently should make for greater efficiency and better service with regard to **exports to Canada** to United Kingdom manufacturers and quite possibly, in the long run, some reduction in the overall costs to British industry.

The approval system operated by the Canadian Standards Association and which governs all safety features of all types of electrically-operated equipment is mandatory and forms probably the most stringent set of requirements operating in any country. It acted as a serious barrier to British exports in the year after the last war.

The agency not only provides approval and consultative services in respect of the electrical approvals system but also provides somewhat similar services in respect of boilers and pressure vessels, and welded fabrications being exported to Canada.

A further important feature of the Canadian approvals system is the follow-up inspection procedure that is put in operation after approval is released to manufacturers and which includes periodical visits to all licensees' factories to make certain that the requirements are being maintained. Until recently and in line with the Canadian Standards Association arrangements on their home ground, the re-inspection procedure was operated by the C.S.A. under their own district engineer in London and did not come within the scope of the B.S.I./C.S.A. agency authority. The C.S.A. recently negotiated a new agreement with the B.S.I. and have now shut down their district engineer's office in London and transferred the whole of this work to the B.S.I./C.S.A. agency.

The agency has operated from the B.S.I.'s Hemel Hempstead testing centre for the past two years and from now on all matters relating to Canadian approval and maintenance of approval will be dealt with by the principal officer and the staff of the agency, located at Maylands Avenue, Hemel Hempstead, Hertfordshire.

A start has already been made to provide the Canadian manufacturer with the same kind of service that his British counterpart is receiving and it is hoped in the future that this reciprocity will increase and where appropriate the necessary testing of Canadian manufacturers' equipment may be carried out in the Canadian Standards Associations' testing house in Toronto prior to its shipment to the United Kingdom.

Alenco Ltd. announce the purchase of two Dutch companies, Ermeto Productie Maatschappij N.V. and P.L.W. De Ridder & Co., N.V. (Ridco). Ermeto Productie Maatschappij was formed in 1948 for the purpose of manufacturing Ermeto fittings for the Dutch market; at the same time Ridco was formed to market the fittings produced by E.P.M.

The two companies are distinct and have quite separate organisations. The only connecting link between them is Mr. P. L. W. De Ridder himself who, from the beginning, has been managing director of Ridco and joint managing director of E.P.M.

It is the intention of the British Ermeto Corporation, one of the Alenco group of companies, to supply Ridco with Ermeto fittings, particularly those which cannot be economically produced by E.P.M. A considerable increase in B.E.C.'s export to Holland can, therefore, be expected.

SPECIAL nucleonic instruments, developed in Britain, will soon be helping the spread of automation in Russia's steel industry.

Davy and United Instruments Ltd. have signed a contract with Stankoimport of Moscow, for the supply of eight transmission gamma ray thickness gauges to be installed in Russian steel mills. These gauges use a radio-active isotope as the measuring medium and are capable of continuous measurement to extremely fine limits of accuracy on anything from white-hot steel plate to cold strip. They perform this measurement automatically without any necessity for touching the material being rolled.

One of the gauges will be used for measuring hot steel plate between 3·75 mm and 50 mm thick. Another will be used on a hot strip mill for measuring hot rolled strip between 1·5 mm and 12·5 mm thick. The remaining six gauges will all be installed on cold strip mills and will be measuring cold steel strip between 1·5 mm and 12·5 mm thick.

The value of the contract exceeds £90,000; it has been negotiated through the Trade Delegation of the U.S.S.R. in the United Kingdom. Delivery will take place during the first quarter of 1962. As is customary with Davy-United radiation instruments of this type, the radio-active source and detection device will be supplied by Isotope Developments Ltd., of Reading.

BEREC INTERNATIONAL LTD. the Export Sales organisation of The Ever Ready Co. (Great Britain) Ltd. have joined with Compagnie Industrielle des Piles Electriques (CIPEL) of Argenteuil to form **Berec France S.A.R.L.**

From their offices at:

125, rue du President-Wilson,
Levallois-Perret,
Seine,
France.

this new company will supply "Berec"

flashlight batteries and radio batteries to all territories within the franc area.

At the present time executives of Berec France are engaged upon market surveys of several of these countries.

ELECTRICAL CONTROLS for 17 pumping stations are to be supplied by **Brookhirst Igranic,** to the city of Baghdad sewerage board for new main drainage scheme.

The order has been placed by Pulsometer Engineering of Reading. Consultants and civil engineers for the scheme are John Taylor & Sons.

A SECOND order for several hundred axial flow blowers has been received from L. M. Ericsson of Sweden, by **Plannair Ltd.,** specialists in air movement. This is a repeat of last November's order placed by the same company for Plannair air movement equipment.

SERVICES

Decca Radar Ltd. have recently established a computer tape service at their Hersham laboratories where tapes undergo a series of rigorous tests prior to being graded and supplied to computer users.

All tapes subject to these tests must comply with strict mechanical and electrical acceptance specifications; they are then graded according to their rejected regions, that is, areas of confirmed drop-out or drop-in which are shown to occur at the same positions on the tape during repeated play-back. Tapes which are completely free of rejected regions are classified as Grade 1; Grade 2 tapes may contain limited rejected regions.

After completion of the tests each tape is coded according to its magnetic and mechanical specification and identified by a serial number printed on the backing side of the tape leader. It is then wound on a spool and packed in a dust proof polythene bag, finally being stored in either a metal or cardboard container ready for shipment.

A NORTHERN computing service, available for industrial, scientific and commercial calculations, has been set up at Manchester by **Ferranti Ltd.** Initially this service will be based on a Pegasus general-purpose digital computer at the company's head office at Hollinwood.

Arrangements for using the service will be quite flexible, as at the Ferranti computing service centres in London. Clients may prepare their own programmes or hand over the complete job to the computing service staff.

Facilities are also available for hiring time on a number of other Ferranti computers, at universities, technical colleges or commercial organisations in London and Scotland.

EDUCATION

A school for training engineers in the use of electronic equipment has been established by Associated Electrical Industries Ltd. at New Parks, Leicester, headquarters of the Electronic Apparatus Division. Trainees include not only members of the company's Construction Department but also customers' engineers.

The courses will enable AEI Construction Department electronic specialists to keep up to date with the rapid and advanced developments taking place within the electronics industry; to extend the knowledge of engineers specialising in heavy current electronic engineering; and to train newly qualified engineers in current techniques in industrial electronics.

At present there are two types of courses—the advanced, dealing with electronic machine tool control systems, lasting approximately five weeks, and an elementary course, on simpler equipments, over five days.

A NEW **industrial film catalogue** is announced by the G.B. Film Library.

The catalogue is a comprehensive guide to the visual aid material available from the library which can be used for training and education purposes by industry, and which has previously been included in separate publications. The aim has been to provide one complete catalogue covering all industrial needs.

For ease of reference it is divided into four sections. Films for industrial training, including the salesman-training series; technical educational films; sponsor (free hire) films, and technical film strips. In this last category will be details of two new sound filmstrips.

Each film has its own synopsis, and hire and purchase prices are given. Information is given about the other facilities which the Library are able to offer to industry. These include complete sound recording facilities, sponsored film distribution and mobile projection arrangements for organisations who do not have their own equipment.

VISITORS

FOLLOWING informal discussions between Sir Roger Makins, chairman of the United Kingdom Atomic Energy Authority, and Professor V. S. Emelyanov, director of the U.S.S.R. Main Administration for the Utilisation of Atomic Energy, Professor Emelyanov and a number of his colleagues visited the United Kingdom recently. They discussed with the Atomic Energy Authority arrangements for further collaboration in the **peaceful uses of atomic energy** and visited some nuclear establishments in the United Kingdom.

ASSOCIATIONS

AN indication of the way in which **BEAMA** is adapting its organisation to developments within the electrical industry, is given by the announcement of the establishment of two new Sections—the Industrial Electronic Equipment Section and the Nuclear Reactor Section.

In addition to the day-to-day work relating to technical matters, standardisation, exports and statistics, the Industrial Electronic Equipment Section will also provide a means of closer discussions with other associations and help towards the wider examination of general policy questions affecting the industrial electronics industry as a whole. Mr. W. Gregson, of Ferranti Ltd., has been elected chairman, and Mr. R. J. F. Howard, of Metal Industries Ltd., is vice-chairman. Mr. A. Newton has been appointed secretary.

The Nuclear Reactor Section will cover nuclear reactors for electrical power applications. Membership of the Section will be open to all those members of the BEAMA who, as participants in groups or consortia concerned with the design and building of nuclear reactors for electrical power applications, undertake contractual responsibility for the operation of these reactors. The present members are Associated Electrical Industries Ltd., The English Electric Co. Ltd., The General Electric Co. Ltd., C. A. Parsons & Co. Ltd. and Babcock & Wilcox Ltd.

The establishment of this Section ensures that the interests of BEAMA manufacturers over the whole field of plant and ancillary equipment for nuclear power generation are covered by appropriate Sections of the Association.

Mr. G. T. H. Spurling has been appointed secretary of the Nuclear Reactor Section.

THE **BEAMA Council** for the year 1961/62 includes several members who will be serving for the first time and in addition brings back to the Council in the new office of counsellor a number of prominent figures in the industry who have previously held the office of president or chairman. The new members of the Council are as follows:

Counsellors

The Rt. Hon. Viscount Chandos of Aldershot (Associated Electrical Industries Ltd.).

The Rt. Hon. Lord Nelson of Stafford (English Electric Co. Ltd.).

Sir Vincent de Ferranti (Ferranti Ltd).

W. K. G. Allen (W. H. Allen Sons & Co. Ltd.).

J. O. Knowles (Metal Industries Ltd.).

Members

E. B. Banks (English Electric Co. Ltd.).

R. M. Fairfield (British Insulated

A small party of Russian engineers were guests recently at the St. Helen's Auckland factory of Westool Ltd. Their visit follows the recent visit to Russia of Westool director Col. C. E. MacKellar.

In this group, taken outside the Westool works, are: (left to right) A. C. Stewart, sales manager, Westool Ltd.; J. B. Bailey, application engineer, Westool Ltd.; Col. C. E. MacKellar, director, Westool Ltd.; O. Penkovsky, leader of the Russian party; A. N. Kazantsev, professor at Moscow University; L. E. Dombur, a Russian engineer specialising in machine production control.

Callender's Cables Ltd.).

Sir Joseph Lockwood (Electrical & Musical Industries Ltd.).

W. L. Mather (Mather & Platt Ltd.).

J. D. Morton (Siemens Schuckert (G.B.) Ltd.).

K. Rowell (W. H. Allen Sons & Co. Ltd.).

Sir Charles Westlake (Metal Industries Ltd.).

THE **Electrical Research Association** announces the composition of Divisional Committee No. 1—Insulating Materials.

Dr. L. G. Brazier, chairman (British Insulated Callender's Cables Ltd.); Mr. R. F. Archer (Micanite & Insulators Co. Ltd.); Dr. J. S. Forrest (Central Electricity Generating Board); Mr. V. J. Francis (The General Electric Co. Ltd.); Mr. J. D. Nicholson (Yorkshire Electricity Board); Mr. M. E. Peplow (Central Electricity Generating Board); Mr. W. Reddish (Imperial Chemical Industries Ltd.); Mr. E. H. Reynolds (British Insulated Callender's Cables Ltd.); Mr. T. R. Scott (Standard Telecommunications Labs. Ltd.); Mr. H. Willott Taylor (Southern Electricity Board); Mr. G. H. Thornley (Castrol Industrial Ltd.); Mr. L. H. Welch (London Electricity Board).

Dr. H. G. Taylor, director of the Electrical Research Association, is an ex officio member of the Committee, and the secretary is Mr. G. A. W. Taylor of the Electrical Research Association.

THE composition of Divisional Committee No. 6—Industrial Applications is as follows:

Mr. H. M. Mathews, chairman (English Electric Co. Ltd.); Mr. L. D. Anscombe (Associated Electrical Industries (Rugby) Ltd.); Mr. F. N. Beaumont (British Petroleum Co. Ltd.); Mr. J. S. Boyd (Imperial Chemical Industries Ltd.); Dr. T. E. Calverley (English Electric Co. Ltd.); Mr. W. Casson (Central Electricity Generating Board); Mr. J. O. Knowles (Metal Industries Ltd.); Dr. D. J. Littler (Central Electricity Generating Board); Mr. D. McDonald (Bruce Peebles & Co. Ltd.); Mr. N. F. Marsh (East Midlands Electricity Board); Mr. H. Pryce-Jones (South Wales Electricity Board); Dr. B. Schwarz (Laurence, Scott & Electromotors Ltd.); Mr. F. W. Skelcher (Central Electricity Generating Board); Mr. S. B. Warder (British Transport Commission); Mr. C. G. Whibley (A. Reyrolle & Co. Ltd.).

Dr. H. G. Taylor, director of the Electrical Research Association, is an ex officio member of the Committee, and the secretary is Mr. C. W. Gaddes of the Electrical Research Association.

COPIES of the Annual Report of the Council for Session 1960/61 and of the Accounts for the year ended 31st December, 1960, presented at the Annual General Meeting of **The Institution of Electrical Engineers** on 18th May, 1961, can now be obtained by members of The Institution on application to the secretary.

The Annual General Meeting, in the Institution building, was followed by a lecture by J. A. Ratcliffe, C.B.E., M.A., F.R.S. on "Experimental Investigation of Space".

EXHIBITIONS, CONFERENCES, ETC.

British Institution of Radio Engineers 1961 Convention has the theme "Radio Techniques and Space Research". The Convention will take place in the University of Oxford and last four days, 5th to 8th July inclusive.

The Institution's decision to hold the Convention has been influenced by the value of discussion on the techniques and possibilities for satellite communications to those concerned with the "European Space Launcher Club". In addition to the use of satellites for communications the Convention will discuss research projects such as those which are to be carried out in the British satellite scheduled for launching by the American "Scout" rocket towards the end of this year. Other papers will deal with radio astronomy—the post-war science which has played such a notable part in conjunction with both research and communication satellites—and with satellite tracking.

The programme of the Convention will be made up of a number of sessions with the following titles:

Radio Techniques in Space Research
Satellite Engineering
Extra-Terrestrial Measurements
Techniques in Radio Astronomy
Satellite Communications

The sessions on Satellite Engineering and Communication Satellites will each occupy a full day.

The Institution expects that about fifty papers will be read at the Convention and contributions will be made by authors from many countries. While emphasis will be on British and Commonwealth achievements and proposals, papers from European countries will also be read and several specially invited contributions will be made by leading authorities from the United States and the Soviet Union. Participation in the Convention will be similarly international and some 500 delegates are expected.

The proceedings of the Convention will be published in succesive issues of the Institution's Journal from July onwards.

A Symposium on Photomultiplier Tube Applications will be held at EMI House, Manchester Square, W.1., from 13th to 15th September.

Aim of the symposium is to exchange information on the application of photomultiplier tubes in a wide variety of scientific and industrial fields, and to encourage discussion on the ways in which improvements can be made and new fields opened. To this end, a number of visitors from overseas who are experienced in this line are being invited.

Speakers will include experts in various fields of photomultiplier tube application, such as nuclear energy, spectroscopy, astronomy, upper atmosphere research, television and printing. They will come from government and university research laboratories and industry, in the United Kingdom and abroad.

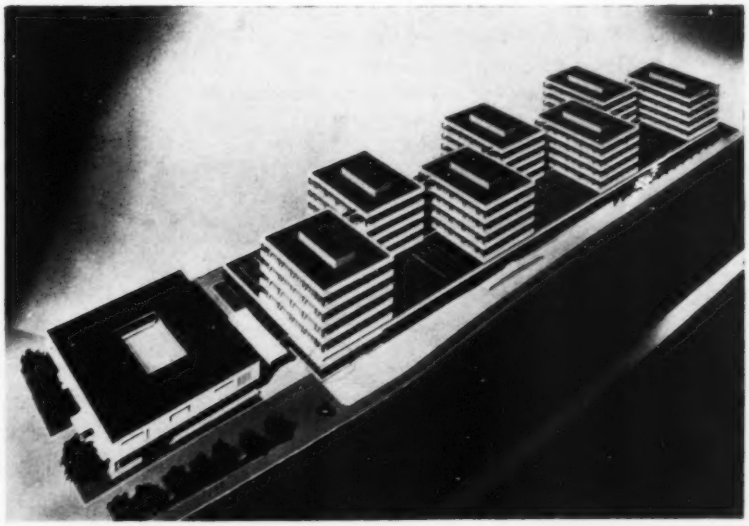
To facilitate discussion in a relaxed and intimate atmosphere, the numbers attending will be limited, so early application is invited for application forms to EMI Electronics Ltd., Valve Division, Hayes, Middlesex.

A nominal fee will be charged, to include a copy of the proceedings which will be sent to registrants shortly after the symposium.

Southern Analytical Ltd. are staging an open exhibition at the Hotel Russell, Russell Square, W.C.1, between 10 a.m. and 5-30 p.m. on the 19th - 22nd June inclusive.

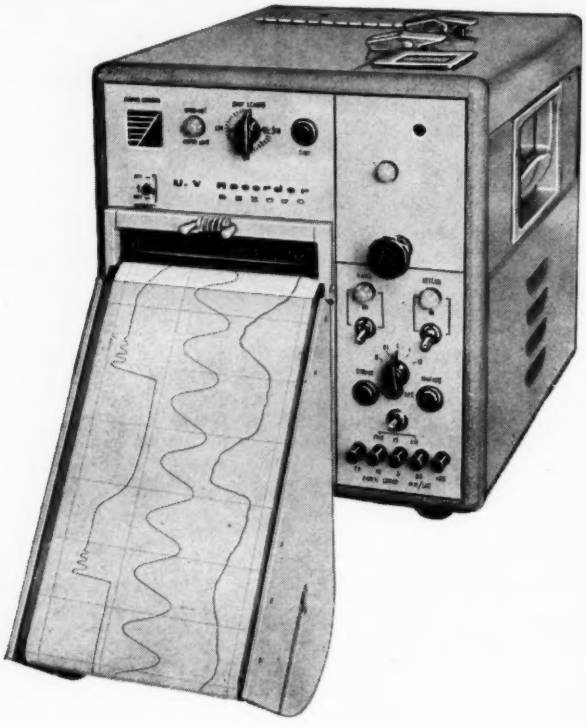
Southern Analytical will be launching two new instruments in the field of trace analysis and quality control by polarography and exhibiting a number of other devices having applications in continuous control of suspended solids in liquids and gases, colour control, gas purification, dissolved oxygen measurement and electro-deposition.

A model of the new factory to be built at Airport works, Rochester, where Elliott Automation are extending their facilities



Circle **360** for further information

SEL introduce a new UV Recorder



with outstanding features:

* **Direct writing with fast presentation**
* **High sensitivity – 1.8μA/cm at 100 c/s**
* **High frequency response – up to 5 kc/s**
* **Up to 50 recording channels**
* **Paper speed range from 1.25 to 2,000 mm/sec, with push-button operation**
* **Trace intensity control**
* **Remote control facility**
* **Shot control – exposes pre-determined lengths of recording paper**
* **Trace identification**

GENERAL SPECIFICATION

This recorder operates on the principle of deflecting a high-intensity U.V. light beam by means of mirror galvanometers across a moving strip of photographic paper. The paper is an immediate print-out type and requires no processing to develop the traces produced by the galvanometers.

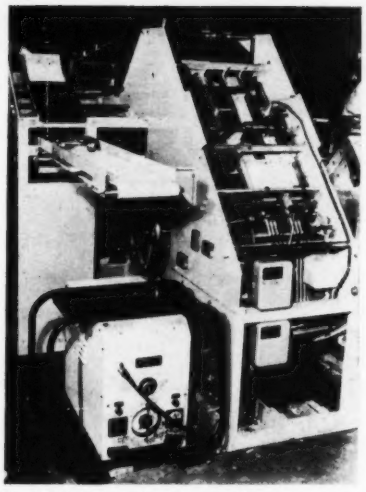
There are two models available:
SE2000 accommodating up to 25 galvanometers writing on 6″ wide paper.
SE2100 accommodating up to 50 galvanometers writing on 12″ wide paper.

The only British Company offering a complete integrated system of Data Handling instrumentation.

For full details of these and other S.E. Laboratories products – transducers for pressure, acceleration and displacement, control and venting valves, frequency/DC converters, flowmeters, demodulators, carrier amplifiers, etc., contact:

S.E. LABORATORIES LIMITED
North Feltham Trading Estate, Feltham, Middlesex
Telephone: Feltham 5876

INSTRUMENT APPLICATIONS



Book binding using r.f. welding

Bookbinding using R.F. Welding

A NEW development in bookbinding has recently been evolved and a Radyne r.f. welding generator is employed with this new technique.

The cover and pages are pre-assembled and hand loaded on to a conveyor which moves them into a punching station, where the book is punched to form a number of slots along the back edge. The punched book then moves to a further station where short lengths of p.v.c. tape are automatically threaded through the slots. The tape is dispensed from reels and a guillotine cuts the required amount for each book, the length of tape on a reel being sufficient for several thousand books.

Replenishing the tape magazine is an operation which takes very little time, fresh reels being clipped into place, after withdrawing the empty spools.

After tape threading, the books move into position on an r.f. welding station, where a pair of cam actuated electrodes effect a tear-seal weld of very narrow width, and neat appearance, on all tapes simultaneously. The books then move on to an off-loading conveyor system, and in doing so pass through a set of "fingers" which removes the surplus "tails" created by the tear-seal welding operation. The ring binding tapes are welded by power supplied from a Radyne Type W.550., 550 watt output welding generator, which feeds the electrode system via a flexible co-axial cable.

This generator has a smoothly variable power output control, which enables tapes of a range of widths and thicknesses to be used, dependent on the type of book being bound.

Finished bound books can be produced at speeds as high as 60 per minute.

Circle **76** *for further details.*

Improved Efficiency at Guinness' Brewery

AT the brewery of Arthur Guinness Son & Co. (Dublin) Ltd., delays were being caused by occasional choking or over-loading of conveyors when feeding ground malt into storage. Since this takes place at the start of the whole brewing process, delays can cause some inconvenience and, if bad enough, might even hold up subsequent operations.

The problem was solved by the application of two Motoload units from Radiovisor Parent Ltd.

Immediate warning of overloading is initiated by the Motoload relay which energises visual and audible alarms; in addition, variations in conveyor loading can be observed on an indicating meter by the operator. Adjustment of the sensitivity of the alarm setting of the equipment can easily be made to allow for normal variations in the loading on the motor driving the conveyor, but the equipment can be set to give immediate warning of any small alterations should the process demand this.

In this particular case the engineers at Messrs. Guinness decided not to stop the motor automatically when overloading occurred because the starters are a considerable distance from the Mill Room; instead the warning signal ensures that an operator takes correcting action on a "Chok" immediately, thus maintaining continuity of feed. The success of the first two units has resulted in a third Motoload unit being fitted to the motor of the whole malt elevator, affording the operators still closer control over the malt transportation system.

Circle **77** *for further details.*

Reflex Detector Aids Medical Research

IMPROVED equipment for investigating nerve impulses, which travel at the rate of some 60-80 m sec, is now in operation in the Department of Medicine at St. Thomas' Hospital, London.

The equipment was developed by the Electronics Department of the hospital, and is much simpler in design and more compact than any system previously available. This simplification has been achieved by using an EMI Electronics' barrier-grid storage tube, a special type of cathode ray tube which picks out and magnifies evoked nerve signals en route from the stimuli to the brain.

These signals can be recorded photographically from a trace on the face of an oscilloscope fed by the storage tube, and thus the rate of travel of the nerve impulses can be determined.

To reduce electrical interference, the patient is placed in a wire cage in which there is no mains-operated equipment. A pneumatic hammer, which provides a standard mechanical blow, is placed above the patient's ankle tendon. The ankle area is coated with silver paint which ensures good electrical contact with the silver tip of the hammer.

At impact the recording system is triggered off. The blow also causes a minute electrical impulse to travel up the nerve to the brain. Two electrodes placed close together in contact with the skin above the nerve path detect this impulse and feed it through a pre-amplifier to the storage tube and the top beam of a twin-trace oscilloscope.

The hammer blow is repeated 20-30 times. The signals are integrated in the storage tube, so that noise tends to cancel itself out, while the impulses from the "ankle tendon jerk", which occurs at a constant time interval after the triggering-off, are cumulative. Thus when played back on the lower trace of the oscilloscope, the position of the integrated response is indicated by a peak on the time scale.

A sand box is used to immobilise the leg and reduce mechanical artefact. Two additional probes fitted to the calf muscle serve as a reflex check.

The essential function of the equipment, which has been named "Evoked Potential Averager", is to detect very small signals in the presence of random noise, and it can be employed for other sounding techniques where weak evoked signals require detecting.

Circle **78** *for further details.*

Electronic Inspection of Yarn

AN INSTRUMENT for analysing faults and determining the character of fibre distribution in linen yarn has been developed by the Research Department of Short Bros. & Harland's Precision Engineering Division in conjunction with the Belfast textile firm of William Ewart & Son Ltd.

The machine which has been named AMY detects yarn faults, measures the length of small fibre disturbances, grades them into five different length groups and counts the numbers occuring in each group.

The sensing element used in this equipment is the LINRA photo-slubber.

AMY (Automatic Monitor Yarn), a new machine for analysing faults in linen yarn

This is a device in which the yarn is drawn through a slit in front of a photo-electric cell at a rate of 1,800 ft/min. The yarn thickness controls the amount of light falling on the cell, and hence the output voltage. The unit contains another similar photo-electric cell with a slit which is adjustable in width and illuminated by the same lamp. The outputs of the two cells are connected to the inputs of a differential amplifier whose output voltage is therefore related to thread thickness. Faults (known as "slubs") in the yarn produce pulses at the output of the slubber with amplitudes relating to the thickness of the faults and durations proportional to fault lengths.

The start of each pulse initiates the opening of a chain of five gated amplifiers which open and close in sequence, each one opening as the previous one closes. The trailing edge of the pulse is coupled to all five amplifier inputs and is accepted by whichever one is operative at the time of its occurrence.

The output of each amplifier is connected to a counter. The operating time of each gated amplifier is made such that faults up to 0·15 in. in length are recorded by the first counter. Faults in the range 0·15—0·5 in. are recorded in the second, 0·5—1·0 in. in the third, 1·0—2·0 in. in the fourth and longer pulses in the fifth. Faults are thus sorted into five length grades and the number occurring in each grade is recorded.

Circle **79** *for further details.*

Improving Machine Tools using Cawkell's Remscope

MODERN developments in high speed machine tools have resulted in large increases in the stresses on the cutting tool and in the accelerations and decelerations which occur at the beginning of and during the cutting operation. Information on these changes can be of great value to the machine tool designer.

The rapidly changing and transient nature of these variations precludes their measurement by conventional techniques and recourse must be made to electronic methods using suitable transducers coupled to one or more cathode ray oscilloscopes. Even this technique has the disadvantage that the oscilloscope trace must usually be photographed before it can be examined and measurements made. The consequent delays in processing the film appreciably prolong any research project.

Cawkell Research & Electronics Ltd. have recently supplied a complete installation of electronic equipment for measuring the rapidly fluctuating quantities associated with the operation of high speed machine tools. This installation employs Remscopes (storage oscilloscopes) for the display of the resulting waveforms so that photography is unnecessary.

The complete equipment consists of resistance strain gauges and their associated amplifiers, for measurement of the strains occurring in the tool, and piezo-electric accelerometers for the measurement of the accelerations during the cutting operation. A bank of three Remscopes records the voltages derived from these transducers. A fourth Remscope is so arranged that it can take any part of one of the received waveforms and display it on an expanded time-base for detailed observation.

The displayed waveforms, although lasting only a few milli-seconds, can be examined for several minutes; there is adequate time to measure or, if a permanent record is required, to photograph them.

Circle **80** *for further details.*

Aqueduct Inspection by Ultrasonics

A KELVIN HUGHES portable, ultrasonic flaw detector was used by the Bristol Waterworks Co. to survey part of a wrought iron aqueduct.

A series of spots, at regular intervals along the conduit, were selected for measurement, in such a manner as to be fully representative of the complete length of the conduit. The spots were thoroughly cleaned by wire brushing and where the surfaces were rough, were ground by rotary abrasive tools to produce a flat surface of approximately 2 in. square. A film of Polycell paste was then painted over these areas to provide a good acoustic coupling for the probe.

The results revealed limited corrosion, the minimum thickness recorded was 5/16 in. the nominal thickness being 7/16 in. although this thickness would not necessarily be uniform even when new.

Further measurements were made on another section of the aqueduct using the same equipment mounted on a specially constructed trolley, which enabled the operator to adjust the instrument and make the necessary observations without fatigue. For the period of the test, the water was turned out of the aqueduct and small stones, silt and such-like debris, brushed out from the invert of the conduit.

The method was highly satisfactory and the use of ultrasonics enabled the survey to be completed in 10 days, thereby allowing the aqueduct to be put back into service with the minimum of delay.

Circle **81** *for further details.*

Automatic Telephone Accounting

THE Mechanised Ticket Processing Unit at Portsmouth which has just been opened, is the last of a chain of nine units which will ultimately prepare, on up to date mechanical and electronic machinery, the bills for almost all telephone subscribers in the United Kingdom.

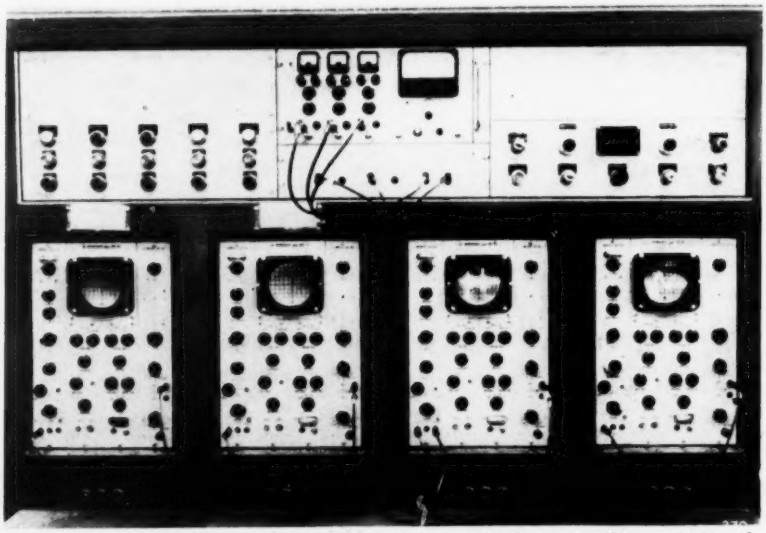
The recording medium used in this system is the telephone ticket printed on a small I.C.T. 40-column card specially designed to permit information to be written or mark coded on it by the telephone exchange operator. The tickets are subsequently passed through a photo-electric mark scanning punch which reads, at high speed, the coded marks and automatically punches corresponding holes. Subsequent processing for account preparation is carried out on a series of I.C.T. punched card machines, most of which have been partly or wholly designed to meet G.P.O. requirements.

At present some 10,000,000 half yearly telephone accounts are despatched involving the processing of 800,000,000 telephone tickets. The restoration of quarterly accounting over the next four years, already announced by the Postmaster-General, will double the number of accounts and, but for mechanisation, would have necessitated the employment of about 1,800 more staff.

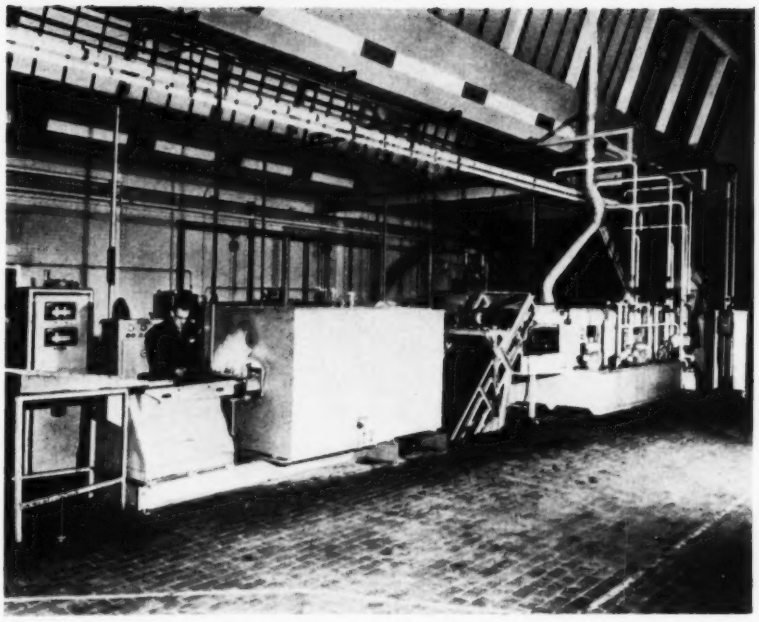
Circle **82** *for further details.*

Heat Treatment Plant for Terry Springs

HERBERT TERRY & SONS LTD. have installed new heat treatment plant in their works at Redditch. Their extensive range of springs and presswork, varying considerably in size and complexity, is now being hardened in shaker hearth furnaces providing closed quench facilities.



The compact bank of four Remscopes and their associated pre-amplifiers which make possible the measurement of the stresses on cutting tools under working conditions



Heat treatment plant comprising Efco 50 kW shaker hearth furnace, quench elevator and washing machine

The new furnaces ensure consistent hardness and a superior surface finish.

In both furnaces the springs are moved through a horizontal heating chamber by an oscillating nickel-chromium hearth plate having a machined and polished surface. The hearth is operated in one direction by an electric motor and in the other by a spring return mechanism, and its oscillating frequency can be varied to give a wide range of conveyor speeds. The heated springs fall from the hearth through a quench chute which is sealed to the furnace casing and has its lower end projecting into the quenching medium. Heating elements are placed above and below the hearth, and around the quench chute to ensure quenching at the full hardening temperature. The elements are spirals of nickel-chromium wire, wound on formers and enclosed in nickel-chromium tubes. They can be removed through the side of a furnace without closing it down. The furnaces provide temperatures up to 950°C.

A controlled atmosphere is used in the furnaces to protect the springs from oxidation and decarburisation. It is supplied by an endothermic generator operating on Town's gas and capable of an output of up to 1,000 ft³/h. To maintain the surface carbon of the springs at the required level the gas : air ratio is set to give a dewpoint at the generator of 20 to 25°F and this is checked regularly with an Alnor dewpoint meter.

The output of the furnaces depends upon the volume-to-weight ratio of the parts being hardened. In the most favourable circumstances the larger furnaces can give outputs up to 340 lb an hour, and the smaller furnace a maximum of 126 lb an hour. The average outputs are however 208 lb and 78 lb an hour respectively.

The shaker hearth furnaces, the endothermic generator and the Alnor dewpoint meter were all supplied by Efco Furnaces Ltd. The automatic washing machine was manufactured by Electro-Chemical Engineering Co. Ltd.

Circle **83** *for further details.*

Specific Gravity Control in Automatic Anthracite Process

A CLOSED loop control system by the Underkoffler Coal Service Co. of Lykens has substantially lowered costs by permitting the preparation of coal with uniform ash content. It also allows recovery of low-ash coal previously discarded as waste.

At the Underkoffler plant, which processes 600 tons of anthracite per day, control is interlocked to a series of valves and mechanical devices to maintain specific gravity of the water-magnetite medium in the separatory system at optimum value and to add magnetite automatically as needed. Control of gravity is held within ± 0·003.

Units used are an electronic circular chart recorder, an electric proportioning unit, a graduated motor, and an AccuRay density measuring unit employing gamma radiation.

The Wilmot heavy media system is a double-hulled vessel with a three-compartmented sump. Fast-draining medium underflowing the lead end of the vibrating screen is sluiced directly to the main medium sump for recirculation to the media vessel. Magnetite remaining is spray-washed into a washings hopper as the coal moves along the vibrating screen. This is pumped to a magnetic separator, which collects and concentrates the magnetite, passes it through a demagnetising coil, and returns it to the main medium sump. Magnetite is further recovered by spray washing at the discharge end of the vibrator; this solution is recovered in a counterflow hopper and recirculated through sprays over coal above the washings hopper. Magnetite recovery is said to be so complete that only 0·4 lb/ton of raw coal feed is required.

The AccuRay unit, which operates on the principle of radiation absorption being proportional to the mass it penetrates, measures to within 0·001 the specific gravity, 1·70, of the medium as it enters the heavy media vessel. The radiation source is mounted on one side of a short section of pipe ahead of the media vessel. The radiation detector is mounted on the opposite side of the pipe.

The electrical signal from the detector is amplified and printed on the electronic recorder. Depending upon the specific gravity, the electric proportioning unit controls either of two motorised valves: one to bleed the circulating medium to a magnetic separator for densification, the other to add fresh water to dilute the medium. The unit also controls a graduated motor which, in turn, operates a rate-adjusting rheostat on the magnetite feeder.

In addition to the main controls, the system also includes an AccuRay level detector on the main sump from which the medium is circulated and a recording-controlling ammeter on the coal feed to the heavy media vessel. Off-normal sump level automatically adds water to the sump, if density is too high, or by-passes medium to the magnetic separator on a low reading. The ammeter measures current drawn by the motor driving the coal feed, shutting down the magnetite feeder if coal feed falls below a prescribed minimum.

Before installation of the automated heavy media vessel, the Underkoffler Co. processed 400 tons of coal per day with jigs using water as the separatory medium. Where ash content of the prepared coal previously ranged from 12 to 16%, it now averages 10 to 11%.

Circle **84** *for further details.*

Pools Postal Order Accounting

I.C.T. SPECIAL PROJECTS are assisting Littlewoods Pools in the task of sorting, counting, assembling and batching each week's football pools investments.

The organisation needed to receive, check, sort, count and assemble several million pieces of paper in 18 working hours each week is, by any standard, an enormous task, especially exacting when each piece of paper represents cash—a postal order. This is only one aspect of the data processing requirement of Littlewoods Pools, and takes no account of the other services concerned, for example, with the checking of coupons, or computations of dividends and their distribution, the statistical control of the operations of six different pools and the maintenance of essential records.

The Special Projects Branch of International Computers and Tabulators Ltd. were invited to collaborate with Post Office engineers and Littlewoods technical experts to devise a machine for reducing the labour of postal order

sorting and counting. The object was additionally to expedite the procedure for handling the weekly cash received by Littlewoods Pools from many thousands of clients whose investments are represented by postal orders of standard denominations, from 6d. to £5, together with irregular amounts made up by the addition of stamps. The result is the I.C.T. automatic postal order counter-sorter, which has been in operation by Littlewoods as a pilot installation since December last.

In order that the machine could operate with a light sensing component the G.P.O. have assisted by "coding" postal orders, the code consisting of three horizontal lines pre-printed at the bottom of the order, the relative positions of these signifying the value of the order.

A stack of unsorted postal orders is placed in the magazine of the sorter, face upwards, with the lower edges leading. The orders are then automatically fed through the sorting mechanism, which consists of a light source above the track and an arrangement of photocells below. Each of these cells is situated opposite one of the positions in which a code mark can appear. Additional photocells identify the presence of a stamp or stamps on the order.

Postal orders pass in succession through the sensing unit at the rate of 450 a minute and are then directed towards sixteen receivers or boxes, 12 of which are coupled in pairs, into which the orders are diverted as directed by the sensing mechanism according to their values. The orders are automatically counted separately for each receiving pocket. When a receiving pocket has its allotted complement of 400 postal orders, the flow is diverted to the adjoining box of the pair, so that no time is lost while the operator removes the completed batch, which represents a convenient quantity of each denomination for banking.

Because this is a pilot installation only, postal orders of the four most popular values are excluded from the setting of the machine and are manually extracted in advance. The machine, however, can be set to any range of values desired according to the frequency of the denominations required to be dealt with. Of the remaining denominations of postal orders, experience has shown that the values of 1s., 1s. 6d., 3s. 6d., 4s., 6s., and 10s. are the majority. The sorter is, therefore, set to extract these values in the first "pass", postal orders of other values being segregated into two boxes designated "A" and "B". Into Box "A" postal orders valued 4s. 6d., 7s., 8s., 9s., 15s., and 20s. are temporarily assigned and Box "B" receives all the other values. Postal orders bearing stamps are directed to a separate pocket for visual examination and separate treatment. Postal orders of any value of which the sensing mechanism is unable to identify are directed to a further separate pocket.

For the second pass, the machine is re-set and the orders of the six values from Box "A" are fully sorted. At the third pass six values from Box "B", i.e. 6d., 11s., 12s., 18s., 21s., and 40s., are separated and of the remaining denominations, six are directed to Box "A" and six to Box "B". At the fourth pass, all the postal orders of value 13s., 14s., 16s., 17s., 60s., and 100s., from Box "A" (third pass) are fully sorted and it only remains in the fifth pass to dispose of the comparatively few orders from Box "B" (third pass) belonging to the denominations of 19s. and 80s., together with a few of the values 2s., 2s. 6d., 3s. and 5s. which may have been left in from the initial manual extraction.

The "breakdown" sorting pattern, described is only one of the many possible alternative arrangements, the comparative value of each being determined by the relative average numbers of orders of the different denominations to be dealt with from time to time. The pattern may be changed due to the effect of introducing new forecast plans or permutations, or new pools.

It will be appreciated that the number of postal order passages through the machine is in excess of the number of postal orders finally sorted and counted. In order to achieve the complete sorting and counting operation for the whole range of values in one passage through the sorter, a machine equipped with no fewer than sixty-two receiving pockets would be necessary, but it would be uneconomic for the reasons shown below. On average, using the five "passes" described above, the relationship is approximately:—

1st Pass	68%
2nd Pass	14%
3rd Pass	3%
4th Pass	1%
5th Pass	1%
Rejects	13%
	100%

It should be noted that this single pilot sorting machine, presently undergoing exhaustive tests by Littlewoods, is handling a proportion only of the total intake of postal orders received each week.

Circle **85** *for further details*

Automatic Washing of Railway Coaches

CONTROLS for a train washing plant have been supplied to British Railways by Brookhirst Igranic, and are now operating at Ilford.

The plant can be arranged to pre-wet a train of carriages, spray them with cleaning solution and wash all over with felt flails as they pass through the installation at a speed of three miles an hour.

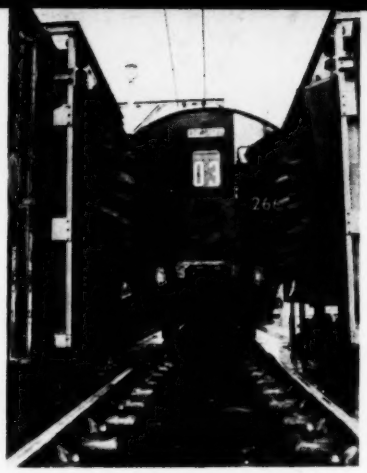
The carriages are reversed through the plant for a final wash.

The complete cleaning cycle can be carried out either automatically or by manual operation.

Circle **86** *for further details.*

Computer Control of Steel Billet Cutting

A steel billet, before it is cut to a customer's requirements may be up to 450 feet in length. If the steel happens to be high quality or, of the stainless variety, it is essential that wastage is reduced to a minimum. In the Stockbridge works of Samuel Fox & Co. Ltd. the problem is complicated by the layout of the mill which necessitates cutting at two or three points.



Felt flails cleaning a coach as it passes through the train washing plant at British Railways' Ilford car sheds

Four factors are involved:

1. The measurement of billet length
2. The calculation of optimum cutting points
3. The transmission and display of this information to operators
4. The recording of data for office purposes.

It appeared that a computing system could be applied here and a joint study was made by Samuel Fox & Co. Ltd. and E.A. Automation Systems Ltd. The result was that a Panellit 609 information system was installed. It incorporates an Elliott 803 general purpose computer.

The measurement of billet length is based on revolutions of the mill rolls, and incorporates a self-calibrating pulse-counting system which compensates for the wear on the rolls. The presence or absence of a billet is detected by lead sulphide cells which are capable of detecting billets which may have been delayed at an earlier stage of rolling and have, therefore, cooled to 400°C or 500°C.

Orders may be for the final billet to be a fixed length, a limited continuous range or for a range consisting of a series of steps. A particular record is set up on a panel under the control of the mill foreman.

The computer must calculate the optimum cutting points making allowances for test pieces and for the variability of the end stops at each saw and shear. The calculation takes less than 1 second and information for the operators is, therefore, available within 1 second of the billet leaving the mill.

Each saw operator has a panel in front of him, and cutting information supplied by the computer is displayed by pressing a demand button. The computer checks that the billet to be cut by the operator is the same as the one whose particulars are displayed on his panel. Similarly, any abnormalities in the operation of the system are rapidly identified and detected.

An interesting feature of the computer is that it converts "hot" feet length of the billet, as measured, to "cold" feet for commercial purposes.

Circle **87** *for further details.*

MANUFACTURERS' LITERATURE

Vibra Screw Feeder

The standard range of Vibra screw feeders consisting of ten graduated sizes with screws ranging from $\frac{1}{4}$ to 4 in. diameter, providing feed rates from a few ounces to tons per hour is the subject of a four page leaflet, WMP. 3M/11/60 issued by Simon Handling Engineers Ltd., under licence from Vibra Screw Inc.

A single totally-enclosed, ball-bearing type motor, rated at $\frac{1}{3}$ or $\frac{1}{2}$ hp according to the size of the feeder, drives both the screw and the vibrator. Standard motors are suitable for 400/440 V, 3 phase, 50 c/s supply: motors to suit special applications or conditions can also be supplied.

There is a table showing the approximate maximum capacity for each size of screw with a material weighing 75 lb/ft^3 as well as constructional details and overall dimensions.

Circle **88** *for further details.*

Capacitors

The English Electric Valve Co. Ltd., now has available a range of high vacuum variable capacitors. This series comprises five types covering the capacitance ranges 5 to 30 pF, 8 to 50 pF, 16 to 80 pF and 5·5 to 206 pF. The electrical and mechanical data of these capacitors are described in a pull out folder at the beginning of the company's brochure U1/5. There is also a separate page for each capacitor dealing with "tuner characteristics" and "outline".

Circle **89** *for further details.*

Gallenkamp News & Review

News & Review, is a bi-annual publication produced by A. Gallenkamp & Co. Ltd. This year's issue is considerably larger than usual in view of the fact that there are brief details, in three languages, of the company's exhibits at the Achema Congress at Frankfurt.

Other items of interest are references to the Lloyd gas analysis apparatus, ballistic bomb calorimeter and Bjerkerud apparatus for hydrogen in steel determinations.

Circle **90** *for further details.*

Co-operative Electrical Research

The latest edition of the Electrical Research Association's house journal entitled *Co-operative Electrical Research* contains among others, an article on the brief history of E.R.A. research on h.v. d.c. transmission. Mention is made of the recent announcement concerning the setting up of a new laboratory to undertake research and development work on large-scale d.c. transmission terminal plant by the C.E.G.B. research department.

Circle **91** *for further details.*

Decca Catalogue

This is the latest microwave instruments and special components catalogue to be issued by Decca Radar Ltd. These instruments have been designed in conformity with the standards established by the Radio Electronics Measurement Committee, Ministry of Aviation, for grade one instruments and have been engineered to provide accurate measurements over the widest possible frequency range. Each catalogue sheet has a reference issue number together with a description and specification of the various instruments.

Circle **92** *for further details.*

Hewlett-Packard Journal

Two additional regulated supplies for higher power transistor use and similar applications have recently been developed owing to the popularity of the small regulated power supply now in operation.

The new Model 722AR provides up to 2 A at voltages from 0 to 60 V d.c. For safety-to-load, maximum available current can be set anywhere between 100 mA and 2·2 A. The unit is also designed to compensate for effect of hook-up leads on regulation.

The other, Model 723A provides up to $\frac{1}{2}$ A at voltages from 0 to 40 V d.c. The unit if fully transistorised and operated at full ratings up to 55°C.

Illustrations of the two new models and specifications are included in the February issue of the *Hewlett-Packard Journal.*

Circle **93** *for further details.*

Furnaces

A brochure from Royce Electric Furnaces Ltd. gives details of their hump-back conveyor furnaces, the heating elements of which are of heavy gauge nickel-chromium wire for temperatures up to 1000°C ("W" type), and heavy grade nickel-chromium tape for temperatures up to 1150°C. ("T" type). The "T" type furnace design is suitable for copper brazing steel and other high temperature applications.

Standard furnaces are made in four sizes in both temperature ranges. General arrangement together with ratings, sizes, and specification are mentioned.

Circle **94** *for further details.*

Speed Gears

Folder AM/1 available from Carter Gears Ltd. gives details of the new 10 hp size AM26 Carter hydraulic variable speed gear, the latest addition to the existing range of Carter hydraulic variable speed gears. It is similar in design to the "A" type range of Carter gears, and incorporates the original torque-sharing positive displacement hydromechanical design.

Sections are devoted to "Performance" "Rating Table" and "Dimensions".

Circle **95** *for further details.*

Computer World

The March-April issue of *Computer World*, a bi-monthly bulletin for executives and engineers published by Ferranti Ltd. contains a number of articles of interest including "Why the Banks need Computers", "Computer for Boiler Control". "Automation in Air Traffic Control" and details of a new computer film which shows the versatility of computers.

Circle **96** *for further details.*

Oscilloscope Measurements

The contents of Parts I and II of "Simple Oscilloscope Measurements", published as separate booklets by the Mullard Educational Service, have now been combined in a single publication.

This new addition to the "Simple Measurement Series" contains suggestions for 37 different experiments, which can be carried out using a simple oscilloscope. A suitable instrument is the student's constructional oscilloscope for which full design and constructional details are published by the Mullard Educational Service.

The experiments have been chosen to cover the syllabuses of schools, and the first year at technical college.

Circle **97** *for further details.*

Low Voltage Power Supply

The latest pamphlet in the series "Demonstrations and Experiments in Electronics", published by the Mullard Educational Service, describes a simple low voltage power supply which will be useful to schools conducting experiments with transistor circuits.

The circuit is essentially a simple half wave rectifier driven from the secondary of a mains transformer delivering 30 V r.m.s. The rectified output is applied to a variable filter network which enables a range of currents from 1 mA to 1·4 A at an output of 10 V to be obtained. Currents of up to 1·9 A can be drawn at lower output volts.

Circle **98** *for further details.*

Servomotors

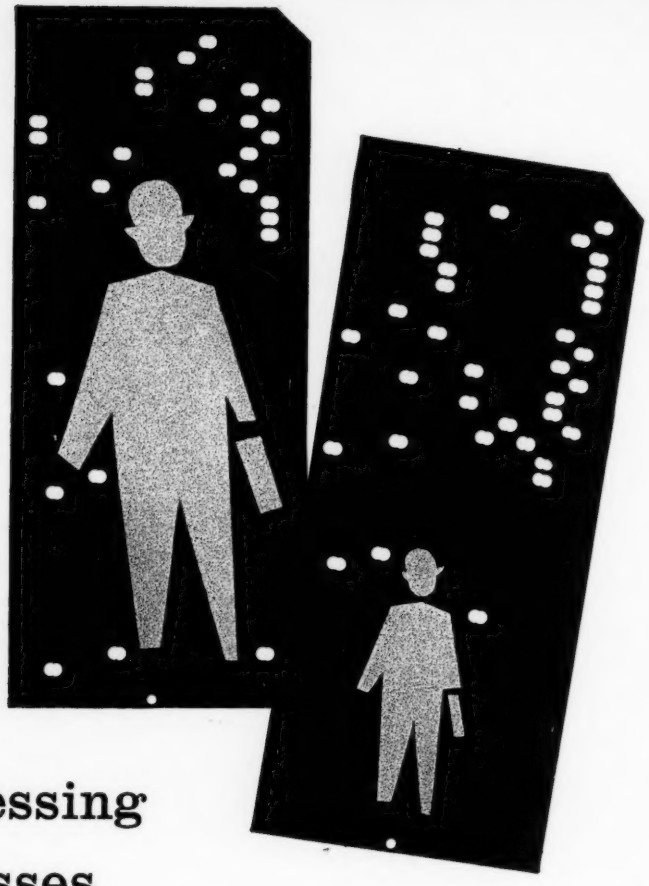
Precision a.c. servomotors conforming to Ministry of Aviation specification EL1789 are described in publication W.21/1 from the Servo Components Division of Elliott Brothers (London) Ltd.

Dimensions and characteristic curves for typical motors are also included.

Circle **99** *for further details.*

(*Continued on Page* 781)

Circle **361** for further information



I·C·T

40-column data processing helps businesses large and small

I·C·T 40-column equipment records the data of your business in the 40 columns of the I·C·T punched card. It uses these cards to sprint through routine business operations. It streamlines the working of organisations large and small: from firms employing less than 100 to undertakings as large as the G.P.O. telephone accounting system—and all sizes in between.

I·C·T 40-column gives you all this: It can mechanise your stores and stock control, invoicing, payroll, hire purchase, expenditure control and costing. The I·C·T punched card can be easily read, used in pulling files and as a dual-purpose document.

I·C·T 40-column is flexible. You can start with the basic machines: punch, sorter and tabulator. At any time you can add summary, reproducing and electronic multiplying punches, collators and interpreters. However fast your business grows, I·C·T data processing can keep pace.

I·C·T Service is unique. I·C·T have over 50 years' experience of data processing, and make the widest range of equipment in Britain: 21-, 40-, 80- and 160-column punched card machines, small and medium sized computers. I·C·T will examine your problems and tell you precisely what they can do to help you. Phone your local I·C·T office or write to us now.

I·C·T DATA PROCESSING

International Computers and Tabulators Limited

149 PARK LANE, LONDON, W1 · OFFICES THROUGHOUT THE U.K. AND IN 51 COUNTRIES THE WORLD OVER

PERSONALITIES

Mr. H. G. Hinckley

Mr. G. A. Marriott

The Lord President of the Council and Minister for Science, Lord Hailsham, has appointed **Sir Harold Roxbee Cox** as chairman of the Council for Scientific and Industrial Research for five years from 1st October, 1961. He will succeed Sir Harry Jephcott, who has been chairman of the Council since its formation under the DSIR Act of 1956, and who will complete his term of office in September. Sir Harold has been a member of the Council since 1957.

Sir Harold Roxbee Cox, D.Sc., Ph.D., D.I.C., M.I.Mech.E., F.R.Ae.S., F.Inst.F., F.I.Ae.S., who is 58, is an engineer by profession and has spent over twenty years in the government service. In this time he has done pioneer work on jet propulsion, gas turbines and problems of fuel and power. After six years as chief scientist of the Ministry of Fuel and Power, he left government service in 1954 for industry, and in January of this year was appointed chairman of the Metal Box Co. Ltd. He is active in the field of higher technological education and is chairman of the National Council for Technological Awards.

Sir Arthur Vere Harvey, C.B.E., M.P., has been appointed to the board of CIBA Ltd, Basle. This is the first time that an executive of the CIBA Group of Companies in Great Britain has been made a director of the parent company and may be considered as an indication of the importance attached by the Swiss board to the rôle of the British companies in this international chemical group.

Sir Arthur joined CIBA in 1957 as chairman of its four British subsidiary companies, CIBA Laboratories Ltd., Horsham, CIBA (A.R.L.) Ltd. Duxford, CIBA Clayton Ltd., Manchester, and the Clayton Aniline Co. Ltd., Manchester. A few weeks ago he was appointed managing director of the newly formed CIBA United Kingdom Ltd., which is acting as the holding company for all CIBA interests in Great Britain.

Group Captain F. C. Daubney, C.B.E., has been elected as chairman of Creed & Co. Ltd., the Croydon telegraph and data processing equipment manufacturers. Vacant since the death of Sir Francis Brake in June, 1960, the chairmanship will be additional to Group Captain Daubney's existing position of managing director.

Mr. F. W. Helmer, B.Sc. (Econ.), has been elected a director of the company.

Mr. J. Bell, formerly a deputy director and manager of The Research Laboratories of The General Electric Co. Ltd., has been appointed managing director of the M-O. Valve Co. Ltd., a subsidiary of The General Electric Co. Ltd., following the retirement of **Mr. G. A. Marriott** at the end of March.

Mr. Marriott retires from his position as managing director of the M-O Valve Co. Ltd., after 42 years' service with the company.

Mr. Marriott was associated with the British Radio Valve Manufacturers' Association from the start, being appointed to the board of management in 1940, elected chairman 1940-42, and 1947-49, and vice-chairman 1949-61.

He was made vice-chairman of the Radio Industries Council 1952-56, president of the British Institute of Radio Engineers (Brit. I.R.E.) 1956-58, first chairman of the Electronic Valve and Semiconductor Manufacturers' Association in 1959, and president of the Association in 1960.

Mr. C. E. Payne (a director of Ferguson Radio Corp. Ltd.), has been appointed to the board of directors of Nash & Thompson Ltd.

The following sales appointments have been made:

Mr. D. D. Williams has been appointed as home sales manager to co-ordinate the activities of the technical sales staff and improve customer liaison. He was formerly commercial manager of Electro Mechan Heat Ltd. a member of the G.K.N. Group of Companies.

Mr. H. K. O. Mehner has been appointed as export sales manager providing overseas customers with better service. He was formerly with International Computers and Tabulators Ltd.

Mr. E. C. Jennett has been appointed to the position of sales engineer for the Midlands area. He was formerly with Wild Barfield Furnaces Ltd.

Mr. P. Bettridge has been appointed to the position of sales engineer for the sale of the new Nashton closed circuit television equipment. Mr. Bettridge has joined Nash & Thompsom from E.M.I. Ltd.

Mr. D. J. Cole, B.A., L.L.B., has been appointed to the board of directors of E. K. Cole Ltd.

Mr. H. G. Hinckley has been appointed manager of the Machine Tool Control Department of Ferranti Ltd., Edinburgh.

He replaces Mr. D. T. N. Williamson, manager of the department since its inception in 1952, who has left to become director of research and development at Molins Machine Co. Ltd., in London.

Dr. Roger A. Bones, B.Sc., Ph.D., A.Inst.P., has now joined The Wayne Kerr Laboratories Ltd., as head of the company's Contracts Division.

To take up his new appointment with Wayne Kerr, Dr. Bones leaves the de Havilland Aircraft Co. where he was a member of the Blue Streak team responsible for technical assessments of trials and the preparation of reports in connection with these trials.

Mr. D. R. Hunt has been appointed a director of Alto Instruments (Great Britain) Ltd. He will be responsible for all sales and production aspects of the company's business.

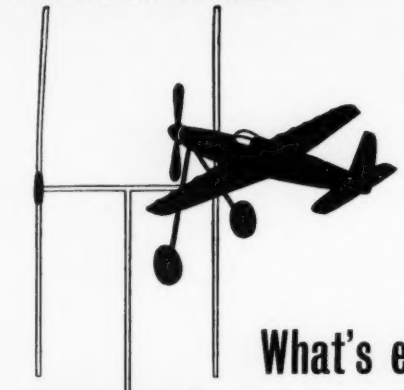
Mr. Hunt served an engineering apprenticeship with the de Havilland Aircraft Co. and, after entering the instrument industry, became sales manager of Fischer & Porter Ltd. Following a period as commercial manager with Power Auxiliaries Ltd., he was appointed general manager of Alto Instruments (Great Britain) Ltd. in March, 1960.

Three additional directors have been appointed to the board of Ferranti Radio & Television Ltd. **Mr. R. A. Drummond,** who has been with the Ekco Group for nearly 30 years and who has been sales manager of Ferranti Radio & Television Ltd., since its formation, becomes director and general manager. The other new directors are **Mr. N. T. Atkinson** and **Mr. A. C. Segger.**

Mr. D. R. Hunt

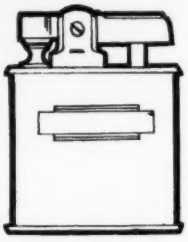
Dr. R. A. Bones

Circle **362** for further information



Simply this. In each one of these famous products with famous names, a simple piece of metal tubing enabled their function to be performed more economically and effectively. A simple piece of metal tubing . . . *but the right tubing.* Ellay small diameter non-ferrous tubing precision made for the part. This brand of tubing can do a lot for you as well . . .

What's exciting about these homely articles?



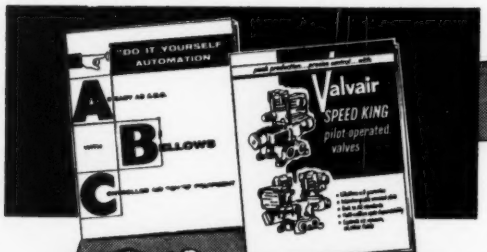
Our output of small light metal tubes includes:—
Tubes from 3/64" to ¾" o.d.
From 3/32" to 20' 0" lengths
From 0.006 to 0.064 wall thickness
In general purpose, close or precision tolerances
In super purity, commercial purity or alloys

We also supply tubes in copper and brass, and precision tubular parts in non-ferrous metals to your specifications.

Everyone has a use for Ellay Tubes

ELLAY Tubes LTD.

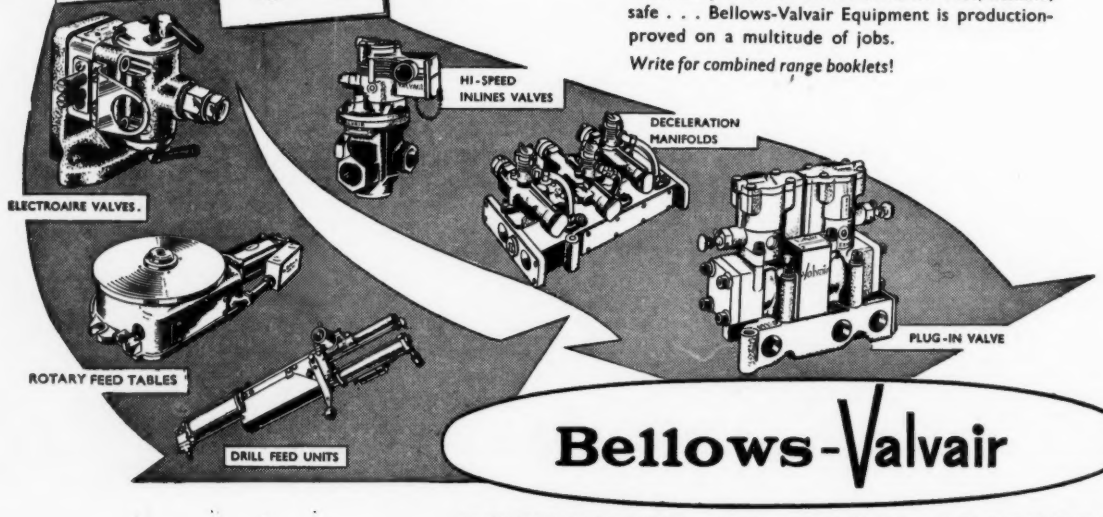
ELLAY TUBES LIMITED
Cox Green Works, Maidenhead, Berks.
Tel: Maidenhead 3303



from the widest range of all !

You can now choose air power equipment from the combined ranges of Bellows and Valvair. Most comprehensive choice there is! Fast, flexible, safe . . . Bellows-Valvair Equipment is production-proved on a multitude of jobs.

Write for combined range booklets!



Bellows-Valvair

CONTROLLED AIR POWER EQUIPMENT

BELLOWS-VALVAIR LIMITED, 1206 STRATFORD ROAD, HALL GREEN, BIRMINGHAM, 28. Tel.: Springfield 6039

Circle **363** for further information

Mr. G. Miller

Mr. P. J. Coe

Mr. E. Dunne

Mr. Brian M. Lee, manager of the Industrial Division of Belling & Lee Ltd., was appointed to the board of executive directors on 4th April.

Mr. J. C. Childs has been appointed works manager of Sheepbridge Stokes Ltd, Chesterfield.

Mr. Childs was previously with an associate company, Sheepbridge Alloy Castings Ltd. as methods engineer, and was apprenticed at the Austin Motor Co. Ltd. where he gained considerable experience on flow-line and mass production machining methods.

The Wayne Kerr Laboratories Ltd., have appointed **Graham Miller** home sales manager responsible to general sales manager Mr. Gordon Ball for the sales of all Wayne Kerr instruments in Great Britain.

Mr. Miller studied electronics at Manchester College of Technology and was a graduate in Physics at Swansea University. He subsequently became a circuit design engineer and spent two years as head of the Ferranti Standards Laboratory at their Wythenshawe Laboratories.

Mr. P. D. Mitchell, formerly assistant sales manager of Polypenco Ltd., has been appointed technical sales manager, responsible for technical sales development, new product research and general sales promotion. A graduate of the Institution of Production Engineers, Mr. Mitchell was formerly a planning engineer with the de Havilland Aircraft Co. Ltd. He joined Polypenco Ltd., in 1958.

Mr. E. Smedley has been appointed sales office manager. He has been with the company since 1959.

The Plessey Co. Ltd., announces the appointment of **Mr. L. Walker, M.I.E.I., A.R.Ae.S., M.A.S.Q.C.,** as company chief inspector for The Plessey Group of Companies.

Mr. Walker was previously company chief inspector with Scottish Aviation Ltd. He has served with B.E.A., and before the war was engaged on inspection work with Imperial Airways Ltd.

Mr. F. Murphy has recently joined Metal & Pipeline Endurance Ltd., as a senior cathodic protection engineer. His principal activities will be in connection with the various pipeline cathodic protection projects being carried out by MAPEL. Prior to joining this company Mr. Murphy was technical director of Metal Economics (Seaguard) Ltd., and was also at one time corrosion engineer for Shell in Venezuela.

Mr. M. N. Beauchant, manager of the International Division of Wallace & Tiernan Associated Companies toured the Scandinavian countries during April and May to contact customers and prospects in the industrial and waterworks field. Wallace & Tiernan manufacture chemical control equipment and a large number of installations of their plant have been made in various countries throughout the world for sterilisation of drinking water, treatment of industrial water and trade wastes. Their equipment includes dry chemical feeders, navigation aids such as marine lanterns and fog horns, precision instruments for pressure measurement and control.

Mr. Arthur Bulgin (A. F. Bulgin and Co. Ltd.), has been elected president of the Radio and Electronic Component Manufacturers' Federation, in succession to Mr. E. M. Lee (Belling and Lee Ltd.). Mr. Bulgin was one of the six manufacturers who met in 1932 to form the Federation.

Dr. G. A. V. Sowter (Telcon Metals Ltd.), succeeds Mr. Hector V. Slade (Garrard Engineering and Manufacturing Co. Ltd.) as chairman.

Mr. Slade and **Mr. K. G. Smith** (N.S.F. Ltd.) have been elected vice-presidents.

The new Council is as follows: Belling and Lee Ltd., A. F. Bulgin and Co. Ltd., A. H. Hunt (Capacitors) Ltd., Multicore Solders Ltd., Painton and Co. Ltd., Plessey Company Ltd., Standard Telephones and Cables Ltd., Telcon Metals Ltd., and Bakelite Ltd. (associate member).

Mr. N. M. Miskin, M.A. (Oxon), has been appointed as Legal Adviser to the British Electrical and Allied Manufacturers' Association in succession to Mr. K. F. A. Johnston. He will take up his appointment on the 1st May. Mr. Miskin is a barrister and practised for a number of years before undertaking legal responsibilities in industry. He is at present with the Federation of British Industries.

Mr. Geoffrey Barnes, B.Sc., A.M.I.E.E., has joined the staff of Ultra Electronics Ltd., as an executive engineer.

Mr. Barnes is at present spending a month in the Ultra Electronics research, development and production departments at Western Avenue. Following this he will be based at Shoreham as Ultra Electronics liaison officer with Miles Electronics Ltd. The acquisition of a third share in Miles Electronics by Ultra Electronics Ltd., was recently announced.

Solartron Electronic Group Ltd., have appointed **Mr. Edwin Dunne, A.M.I.E.E.,** as chief inspector, Farnborough Plant.

Mr. Dunne joined Solartron in January, 1961, having held the posts of deputy chief inspector, De Havilland Propellers Ltd., and chief inspector, A. C. Cossor Ltd., and Cossor Radar & Electronics Ltd.

At the last meeting of the Council of the Electrical Research Association, it was agreed that the vice-chairman, **Mr. L. Rotherham,** should be invited to take the chair for the year 1961/62 and he was duly elected to take office immediately following the Annual General Meeting on 3rd May, 1961.

At the same meeting **Mr. S. E. Goodall** was elected vice-chairman of the Council.

The new sales manager of Cossor Instruments Ltd., is **P. J. Coe, A.M.Inst.E., Grad.I.E.E.,** previously senior technical representative. Apprenticed with A. C. Cossor Ltd., in 1947, he has had all round training—components design and manufacture, equipment design and manufacture, radio, T.V. transmitters, instruments and radar.

Mr. K. J. H. Adams has been appointed production manager of the Semiconductor Division of Brush Crystal Co. Ltd.

Mr. Adams was formerly senior production engineer at Semiconductors Ltd. He is an Associate of the Institute of Physics and an Associate Member of the Institute of Electrical Engineers.

Mr. W. E. Bardgett, reseach manager in the research and development department of The United Steel Co. Ltd. will retire from this position on 1st July, but will remain with the department as a consultant. **Dr. K. J. Irvine,** at present deputy reseach manager, will succeed Mr. Bardgett with the title of metallurgical reseach manager.

Mr. R. Blackwell of Hagan Chemicals & Controls Inc., Pittsburgh, has been in Britain for several weeks to acquaint major British steel producers with the latest Hagan technological advances in the control of steel furnaces in the U.S.
In the picture, Mr. Blackwell, sales manager of his company's Steel Controls Division, is discussing with a technician a Hagan ring balance meter used to measure and control the gas and air supply to the furnaces.

Circle 364 for further information

SIMPLIFIX

NYLON TUBE COUPLINGS

Simple! Secure! Speedy!

Simplifix Nylon Tube fittings are dependable, practical and economical. They are easily and quickly fitted. No work is needed on the end of the tube because the specially designed brass olive ensures a perfect seal and prevents the tube twisting when the joint is made. The coupling bodies are the same as those used for copper tube. Olives and securing nuts can be supplied separately. Only one stock of bodies is needed to make up fittings for Copper or Nylon Tube.
Simplifix Nylon Tube couplings, olives and securing nuts are available for O.D. tube sizes of $\frac{3}{16}$", $\frac{1}{4}$", $\frac{5}{16}$", $\frac{3}{8}$" and $\frac{1}{2}$". Nylon Tube for these couplings can be supplied in a wide range of colours.

The comprehensive Simplifix catalogue will gladly be forwarded on request, and our Technical Advisory Service is always available.

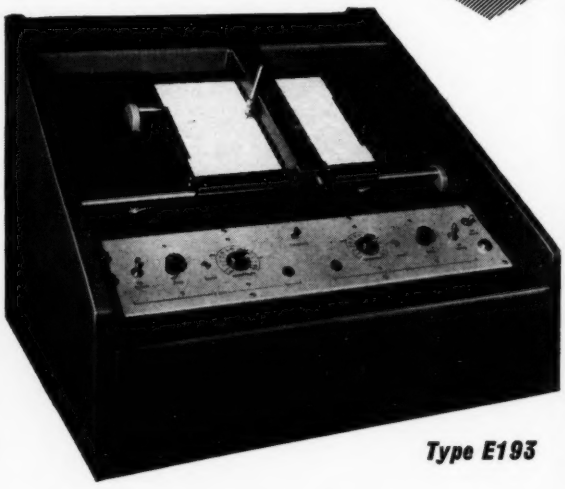
SIMPLIFIX

SIMPLIFIX COUPLINGS LTD · HARGRAVE RD · MAIDENHEAD · BERKS · ENGLAND
TEL: MAIDENHEAD 5100 · A member of the ALENCO Group of Companies

Circle 365 for further information

EKCO

X-Y Recorder



Type E193

Ekco Type E193 is a high-speed X-Y Recorder which plots the relationship between two inter-dependent variables directly on to standard 10" x 7½" graph paper.
The wide sensitivity range (1 mV. per 1" to 50 V. per 1") and exceptionally fast response (full-scale travel in 200 milliseconds) make it unusually versatile in the fields of performance investigation and process control.
This instrument will find wide use in research laboratories, industrial organisations and hospitals or in any field in which it is necessary to chart rapidly-changing parameters accurately.

EKCO ELECTRONICS

Ekco Electronics Ltd., Southend-on-Sea, Essex, England. Tel: Southend 49491

WPS-306

J. C. Simmonds, M.Sc. (Eng), Ph.D., M.I.E.E., M.I.Mech.E. has been appointed to the board of Thermionic Products Ltd.

Formerly with the General Post Office Engineering Department (Electronics), Dr. Simmonds joined Airmec Ltd. in 1946 and was appointed managing director in 1954; he is also managing director of British Communications Corporation and deputy managing director of Radio and Television Trust Ltd.

The Wayne Kerr Laboratories Ltd. have appointed **Major E. R. Wilcox** to the post of research and development liaison officer. Immediately prior to his retirement from the Royal Electrical and Mechanical Engineers Major Wilcox was concerned with test and instrumentation aspects of military electronic equipment and weapon systems. His final appointment was as deputy assistant director with the Electrical and Mechanical Engineering Directorate of the War Office, and he is well-known as an active member of various sub-committees and working parties of the inter-service Radio and Electronics Measurements Committee.

Mr. J. E. C. Bailey, C.B.E., M.Inst. Ex., chairman and managing director of Baird & Tatlock (London) Ltd., Hopkin & Williams Ltd., and W. B. Nicolson (Scientific Instruments) Ltd., has been visiting America and Canada to continue discussions with American associates on the further developments in the "Analmatic" range of process control instruments.

Three new directors have been appointed to the board of Brookhirst Igranic. They are **Mr. N. Clark,** the company secretary, **Mr. H. Rothwell,** chief development engineer, who becomes works director, and **Mr. A. E. Williams,** chief application engineer, who becomes chief engineer.

Mr. Brian Pavey, B.Sc., A.M.Brit. I.R.E. has been appointed technical manager of Burtonwood Engineering Co. Mr. Pavey, who since June, 1960, has been gaining experience with U.S. Industries Inc., the American corporation which controls Burtonwood Engineering, took up his appointment on 7th April.

Mr. Stanley Shaw, M.B.E., who during 14 years' service as Welfare and Safety Officer of George Kent Ltd. attended many similar functions in an official capacity, was himself recently the recipient at a presentation ceremony held on the occasion of his retirement. A cheque subscribed to throughout the firm was presented by the company chairman, Commander P. W. Kent, R.N.

For the greater part of his 44 years with George Kent Ltd., where he could claim to be known to almost every employee, Mr. Shaw took a keen practical interest in local welfare activities of all kinds. These voluntary efforts received official recognition in the 1959 Birthday Honours list.

Mr. R. Pearson has been appointed sales engineer for Scotland, Northumberland and part of County Durham as far south as a line east to west through the town of Durham, for Bailey Meters & Controls Ltd. Mr. Pearson will be assuming his duties in that area early June.

Mr. Paul Gotley has joined the board of directors of Electrical Remote Control Co. Ltd.

OBITUARIES

Mr. W. A. Shaw, A.I.E.E., a director of Evershed & Vignoles Ltd., has died suddenly after 48 years of service with the company.

Mr. Shaw was born in London and educated at Bacon's School. Later he studied electrical engineering at the Borough Polytechnic Institute under the late Dr. Henderson. In 1913 he joined the test room staff of Evershed & Vignoles Ltd., and was for several years engaged in development and experimental work on a wide range of instruments. He transferred to the commercial side in 1919 as a technical assistant, and in this sphere he had a wide experience in the application of the company's products. In April, 1949 he was appointed general sales manager in succession to Mr. F. C. Knowles, whose chief assistant he had been for 30 years, and in November, 1953, was elected to the board of the company as sales director. Recently he was appointed company secretary.

For many years, Mr. Shaw has been well-known in the Instrument Industry, and his loss will be mourned by his many friends.

Evershed & Vignoles Ltd. announce with regret the death of **Mr. J. Dawes,** manager of their Power Road cubicle manufacturing factory. Mr. Dawes, who was seventy-seven, joined the company in 1948 and had been working until March of this year.

Mr. Fred Archdale, 68, a director of James Archdale & Co. Ltd., of Worcester, one of the machine tool companies in the Staveley group, died on 18th April, while on holiday in Spain.

He had been actively associated with the Worcester company for 50 years.

The longest serving representative of G. H. Zeal Ltd., **Mr. R. D. Linford,** died suddenly on 20th April. He was representative for the Midlands, London and East Anglia areas.

(*Continued from page* 775)

Precision Grinding

Machine tools, No. 22, a Jones-Shipman publication devoted to precision finishing and productivity contains short case histories illustrating the use of precision machine tools. For example by using a Jones-Shipman Model 1030 production grinding machine, Gestetner have overcome difficulties in producing their new Gestelith offset duplicator. Again a similar application of Model 1212 high precision cylindrical grinding machine has been used in conjunction with the production grinding in small batches of the many sizes of plug gauges ranging from 0·005 to 6 in. manufactured by E.S.T. (Gauges) Ltd. Other models referred to are Model 1012 crush form grinding machine and Model 1049 production grinding machine, and the Model 150 hydrohoner.

Circle **100** *for further details.*

Formica Industrial Journal

The nature of Formica products deals with a diverse range of industries. The purpose of this journal is not only to show the variety of applications but it should also give some picture of developments and experiments in many kinds of companies. The winter-spring number contains various articles of interest. One entitled "Insulation Strength Space" deals with the use of grade DLE.1 Formica material which combines good electrical and mechanical properties, besides being suitable for use under oil and having a relatively low water absorption. Another deals with "Valves & Vision", where grade MTF/1 specially developed for Mullard as an insulator under high voltage, withstands in some cases 600 V d.c. with currents of as much as 200-230 mA.

Circle **101** *for further details.*

Soviet Science in English

A 55 page booklet has been published by Program for Scientific Translations, giving abstracts in English of key publications in recent Russian literature which have been translated by PST.

The abstracts are collected under subject headings which include: electronics, fuel technology, hydrology and hydraulic engineering, mechanical engineering and technology and physics and mechanics.

There is also an index of titles and authors.

During 1961 PST plan to translate 60 new publications.

Circle **102** *for further details.*

Cropico

This is the title used by Croydon Precision Instrument Co. for their new publication. The instruments described and specified include potentiometers, precision vernier, portable and portable thermo-couple types, resistance boxes and standards, Wheatstone bridge, a Kelvin ohmmeter and a strain measuring bridge.

Circle **103** *for further details.*

(*Contined on page* 782)

SOCIETY OF INSTRUMENT TECHNOLOGY

Control Section

On the 7th April the Control Section held an exhibition meeting at Northampton College of Advanced Technology in London which was attended by over 100 members and non-members of the Society. The subject of the meeting was " Aids to Training and Education in Automatic Control ".

By kind permission of the Principal of the College, the Great Hall was made available to the Society and some 30 exhibits were available for examination during the morning. The exhibits were fairly equally divided between Universities and Technical Colleges on the one hand and industry on the other hand.

It is not possible in this report to describe every exhibit but the following gives some idea of the scope covered.

The University of Southampton (Mr. Parks) and the Birmingham College of Advanced Technology (Mr. Steel) were both showing devices which are not concerned directly with automatic control but with dynamic analysis, which generally leads up to control theory. Mr. Parks showed a torsional pendulum with variable viscous damping (a linear system) and also a compound pendulum working on compressed air bearings (non-linear system). Mr. Steel's exhibit demonstrated the same principle as the torsional pendulum, but used two coils moving in magnetic fields to provide the damping. Forced oscillation can also be observed by applying low frequency alternating currents to the coils.

The Royal Military College of Science at Shrivenham, the Brunel College of Technology, the R.A.F. Technical College at Henlow, and the College of Aeronautics at Cranfield were all showing model servo systems designed so that students could prove to themselves the application of servo theory. It was interesting to see that on the Cranfield College servo it was possible to turn it into a sampled data system by a simple modification.

Cranfield College was also showing a hydraulic servo and demonstrated methods of measuring the characteristics of a spool valve forming part of the system.

Pneumatic control systems were shown by Brunel College of Technology, Queen Mary College, Northampton College, Taylor Controls Ltd., and Foxboro-Yoxall Ltd. The exhibit from Queen Mary College was a purely pneumatic scheme with no transducers which they claimed were liable to introduce errors. Northampton College and Taylor Controls both showed a level control system and the latter also had a flow control system which demonstrated the different controller settings required for these two problems.

Mr. Medlock of George Kent Ltd., brought along his mechanical plant simulator which can be used to simulate a plant involving heat transfer.

More complex equipment was being shown by Feedback Ltd., (Servomex Controls) and Solartron in the form of analogue computer type of simulators. Mullard's were demonstrating a control logic simulator which can be used to teach methods of building up a control system from basic logic elements. Pioneer Designs Ltd., had some useful " do-it-yourself " servo components for those who might want to build up their own model servos. The same firm also showed a synchro trainer designed to teach the principles of synchro systems to those who might have to maintain them.

Some Russian control equipment had been expected but unfortunately the more interesting exhibits had not been cleared by the customs. Two simple examples of Russian teaching aids were available and were being shown by Mr. Lindsay-Carl of Negretti & Zambra.

After lunch the more formal part of the proceedings started, with Professor G. D. S. MacLellan, chairman of the Control Section, in the chair. Dr. Taite, the principal of Northampton College, welcomed the gathering and spoke of the need for co-operation between industry and education. Mr. Medlock, past-president of the Society, then thanked Dr. Taite for having allowed the Control Section to hold the meeting in Northampton College.

Each exhibitor then talked for five minutes about his equipment, describing how it was used and mentioning any interesting features.

After this, the meeting was thrown open to discussion. Much of the discussion centred round the question of whether simulators should be used for education and training at all. It was clear that the Universities on the whole felt that analogue simulators distracted attention from the fundamental principles which they were aiming to teach. On the other hand colleges such as the R.A.F. College at Henlow stressed the practical aspect of training personnel, who would eventually have to use simulators for the design of real systems.

Another question that was brought up by a number of people was how early in a control course should non-linearities be introduced. Some thought that their introduction too early in the course might prevent a proper understanding of the basic theory of linear systems but others pointed out that all practical systems are non-linear to some extent and that the student should be made aware of this early in the course.

Mr. Watts suggested that the S.I.T. might consider sponsoring an up to date film to help in training courses on automatic control. Mr. Medlock replied by saying that this was under discussion at the moment and hoped that some progress would be made.

Mr. Hall (of Pioneer Designs Ltd.) put in a plea for some standardisation of educational equipment, pointing out that costs could be reduced if this were achieved.

At the end of the discussion Mr. E. B. Jones, on behalf of the Society, thanked those who had brought along equipment to show and also Mr. G. M. E. Williams for having worked hard to make the meeting a success.

(*Continued from page* 781)

Randalls News

The April issue of *Randalls News*, published by James H. Randall & Sons Ltd. is devoted mainly to mention of their various sorts of cabinets and industrial storage units.

Circle **104** *for further details.*

Test Gear

In a release from Electro Scientific Industries Inc. mention is made of some of their new or revised items. These include universal impedance measuring and capacitance measuring systems, standard and in-line decade resistors and various test gear.

Their distributors in this country are Livingston Laboratories Ltd.

Circle **105** *for further details.*

Rustrak Recorder

Continental Distributors Ltd. the English distributors for products manufactured by Rust Industrial Co. Inc. has recently issued leaflets concerning two versions of the American company's " Rustrak " recorders.

The first leaflet concerns the Rustrak Mac, which is a miniaturised automatic chart recorder. The rated accuracy of this instrument is 2% of full scale and 1% on special. Its maximum response time 1 second and the galvanometer sensitivity is as low as 100 microamperes d.c. The dimensions are $3\frac{3}{8} \times 5\frac{5}{8} \times 4\frac{1}{8}$ in.

The other leaflet gives information concerning the capabilities of the " Rustrak " recorder with the addition of any one of the following accessories: III-A multi-ranger, III-B multi-ranger, 110 decade amplifier and 98 d.c. amplifier.

Circle **106** *for further details.*

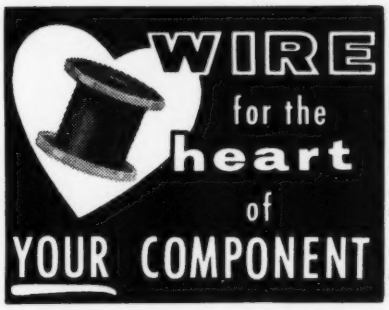
Bearings

Miniature, instrument, roller and special bearings manufactured by Roulements Miniatures S.A. are the subject of the company's RMB catalogue and handbook. The catalogue is designed to assist with the selection of bearings for particular applications.

Two folders are included in the catalogue. These are designed to show the mathematical development of the life of small bearings.

Sole British agents for the company are Miniature Bearings Ltd.

Circle **107** *for further details.*



Wire drawn to your specifications (down to .00025") in base and precious metals and alloys . . . supplied bare, enamelled, ceramic insulated for use at 1000° F., or electro-plated . . . to very close tolerances.

Our research and development staff is available to solve YOUR wire problems.

- 600° C. Insulated Wires
- Strain Gauge Wire
- High Tensile Strength Magnet Wire
- Ribbon Rolled to Close Tolerance
- Sub Mil Pure, Weak Metals
- Resistance Thermometer Wire
- Enamelled Wire
- Fuse Wire
- Semiconductor Wire
- Precision Potentiometer Wire
- Electroplated Wire
- Fine Wire Drawn to .0002
- Galvanometer Suspension Strip
- Custom Melts
- Base, Precious Metals and Alloys
- Indium and Tin Coated Wires
- Electronic Quality Titanium

SECON METALS CORP. SECON

WRITE FOR DATA ON YOUR SPECIFIC NEEDS TO SOLE AGENTS IN THE U.K.

LEONARD WADSWORTH & CO. LTD.

BANK BUILDINGS · WIMBLEDON HILL ROAD · S.W.19

TEL. WIMBLEDON 9871/3

CLASSIFIED ADVERTISEMENTS

If you want to emphasise your firm's services or equipment; if you wish to advertise a vacant situation, buy or sell equipment, the Classified Advertisement columns of "INSTRUMENT PRACTICE" will prove a valuable medium for your announcement—and bring results quickly.

SITUATIONS WANTED –	4d. per word, minimum 6/–
SITUATIONS VACANT –	6d. per word, minimum 10/–
CAPACITIES AVAILABLE–	6d. per word, minimum 10/–
SERVICES AVAILABLE –	6d. per word, minimum 10/–
BUSINESS OPPORTUNITIES	6d. per word, minimum 10/–

Rates for other advertisements may be had on application to:

Classified Advertisement Dept.,

INSTRUMENT PRACTICE

9 Gough Square, London, E.C.4

Telephone: Fleet Street 3172

GLASS

All Glass Requirements for Scientific Instrument Manufacturers and Research Workers

- SHEET & PLATE GLASS—cut and ground to exact dimensions
- LENSES, PRISMS & FLATS — to any standard of accuracy
- MIRRORS — back silvered and front surface aluminised, etc.
- BLOOMING of optical components

C. J. WHILEMS, LTD.

ILFORD OPTICAL WORKS

FOREST ROAD, BARKINGSIDE

ESSEX

Telephone: HAInault 5454-5

The PETROLEUM · CHEMICAL HYDRAULIC · AIRCRAFT AUTOMOBILE and many other industries use

METAL GAUZE FILTERS

Manufactured to customers' individual specifications by

The E. & H. FILTER CO. LTD.

ASHLEY WORKS, ASHLEY ST., LONG LANE, BLACKHEATH, BIRMINGHAM

Telephone BLAckheath 1638

Circle **370** for further information

LABORATORY APPARATUS&

ROYAL HORTICULTURAL SOCIETY'S NEW

Photographs of some of the Stands at the 1960 Exhibition

★ DON'T MISS THIS OUTSTANDING EVENT!

Circle 370 for further information

US& MATERIALS EXHIBITION

NEWHALL WESTMINSTER LONDON S.W.1

A SPECIALISED EXHIBITION

Presented for the second year in succession to enable manufacturers and suppliers to show new equipment and materials which are in actual production, fully tested and readily available. Only apparatus and materials specifically designed for use in laboratories of all kinds are to be seen.

'Laboratory Practice', through its Scientific Advisory Committee, is again arranging an important programme of twelve lectures covering recent advances in laboratory techniques. Each lecture will be given by a specialist in the subject, under the chairmanship of an acknowledged authority in that field. The programme is published in this issue of this journal.

DO NOT MISS THIS EXHIBITION—THE NEXT WILL NOT BE HELD UNTIL 1963

LABORATORY APPARATUS & MATERIALS EXHIBITION

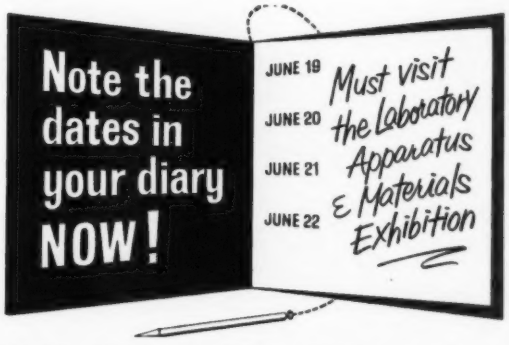
JUNE

19, 20, 21, 22

1961

Sponsored by
LABORATORY PRACTICE

Supported by the
BRITISH LABORATORY WARE ASSOCIATION LTD.



Organised by **U.T.P. Exhibitions Ltd., 9 GOUGH SQUARE, FLEET STREET, LONDON, E.C.4**
Phone : FLEET STREET 3172

CLASSIFIED ADVERTISEMENTS

All advertisements must be PREPAID. Situations Wanted, 4d. per word. Minimum 6s. All other advertisements, 6d. per word, minimum of 10s. Semi-display advertisements, 4s. per line. Minimum £2. Display advertisements at tariff rates. Box Numbers count as four words. Replies forwarded 1s. extra. Replies to Box Numbers must be addressed to *Instrument Practice*, 9 Gough Square, Fleet Street, London, E.C.4.

The Proprietors reserve to themselves the right to refuse to insert an advertisement if they think proper to do so. All possible care is taken to ensure accuracy in setting up the advertisements, but should an error be made the Proprietors will not hold themselves responsible in any way for same.

OFFICIAL APPOINTMENTS

ROYAL Naval College, Greenwich, London, S.E.10. Experimental Officer. Pensionable post for Physicist (man or woman) experienced in Reactor or Nuclear Physics and Instrument Techniques. Duties involve the setting up of experiments, their conduct and detailed design. Age: at least 26 and normally under 31 on 31.12.61. Qualifications normally required: degree or technical qualification (H.N.C.) in appropriate subject. Final year students may apply now. Outer London salary scale £1,132 — £1,386. Starting pay may be above minimum. Write Civil Service Commission, 17 North Audley Street, London, W.1., for application form quoting S/94-95/61/ADY. Early application advised.

SITUATIONS VACANT

REQUIRED for the electrical section of a Works Laboratory, an experienced man who is able to maintain and calibrate precision sub-standard wattmeters and other indicating instruments. Good prospects and salary are offered to suitable applicant. Applications to the Personnel Manager, Landis & Gyr Ltd., Victoria Road, North Acton, London, W.3. Telephone: Acorn 5311.

The Research & Development Establishment
of
AERONAUTICAL & GENERAL INSTRUMENTS LTD.
105-107 Lansdowne Road, Croydon, Surrey
require

Senior Electronics Engineers whom should be qualified at least to Higher National Certificate level and/or have a wide and varied experience of present day electronic technique.

All applications in the first instance to be in writing to the above address.

Shell Chemicals

TECHNICIANS

Petrochemicals Limited have a number of staff vacancies for Technicians with a sound background of Electronics and/or Physics coupled with experience of automatic analysers and other special quality control equipment applicable to the Petroleum and Chemical Industries. The work mainly involves the trouble shooting aspects of a wide range of such equipment and although candidates should preferably have served a mechanical apprenticeship and achieved Higher National Certificate, those who have served an apprenticeship and achieved an Ordinary National Certificate and have the requisite experience will also be considered.

Attractive salaries commensurate with experience and ability, excellent contributory Pension Scheme, staff cafeteria and social and sports facilities. Written applications, bearing reference IP/25/61 should be made to:

Staff Manager,
Petrochemicals Limited,
Carrington Works,
Urmston Manchester.

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

ATOMIC ENERGY ESTABLISHMENT, WINFRITH, DORSET.

INSTRUMENT MECHANIC

Vacancies exist at the Atomic Energy Establishment, Winfrith, for Instrument Mechanics. The duties involved include the major repair and overhaul of the following instruments:

All types of potentiometric recorders, moving coil, moving iron, and dynamometer type precision and commercial grade instruments, pressure, vacuum and flow transducers. Some experience of commercial oscilloscopes, signal generators, and other electronic instruments would be an advantage.

Applications are invited from craftsmen who have served a recognised apprenticeship or the equivalent with experience of the above work.

Certain craftsmen may be eligible for housing accommodation, and for lodging allowances whilst awaiting allocation.

Application forms can be obtained from the Labour Department, A.E.E. Winfrith, Dorchester, Dorset, quoting reference IM/IP/IR.

JLT GROUP

TRANSDUCER DEVELOPMENT

Vacancies exist in our Boreham Wood Laboratory for

SENIOR and INTERMEDIATE TECHNICAL STAFF

to develop mechanical/electrical Transducers. There is full scope for ability, originality of thought and individual effort.

Applications are invited from Engineers to join this leading Company in the rapidly expanding field of Instrumentation Control and Data Processing.

Please apply to:

Group Personnel Officer,
J. LANGHAM THOMPSON LIMITED,
176 High Road, Bushey Heath, Herts.

LIL

INSTRUMENT ENGINEER

A vacancy exists in the **Design Office** (London) of LAPORTE CHEMICALS LIMITED, a Company within the Laporte Group, for a qualified Instrument Engineer.

Applicants should have a good theoretical background and should have experience in the design of control schemes embodying all types of modern pneumatic and electronic equipment in the petroleum or chemical industry.

The post involves responsibility for the complete design, procurement and construction of process control schemes for a wide variety of chemical plants in the several works of the Group throughout this country using the most modern techniques.

A substantial salary commensurate with experience and qualifications will be offered and the position offers exceptionally good prospects.

Apply in the first instance to the Group Personnel Manager LAPORTE INDUSTRIES LIMITED, *Hanover House, 14, Hanover Square, London, W. 1., quoting reference LCL/IPL/39*

A CAREER IN AUTOMATION

Imperial Chemical Industries Limited, Wilton Works

has vacancies for

INSTRUMENT ARTIFICERS

for the installation and maintenance of all types of process instruments in a large new chemical works operating at Wilton in the North Riding of Yorkshire.

This is a comparatively new trade which is expanding rapidly; short training courses are available for tradesmen selected for this work.

Applications are invited from apprentice trained INSTRUMENT ARTIFICERS, FITTERS or ELECTRICIANS.

Trade Union rates of pay are in operation with opportunities to earn bonus. Recreational and welfare facilities are available; there is a pension fund and a Profit Sharing Scheme. A subsistence allowance will be paid pending the allocation of a house.

Apply in writing to the Labour Officer, Imperial Chemical Industries Limited, Wilton Works, Middlesbrough.

A COURSE IN INDUSTRIAL INSTRUMENT TECHNOLOGY

BY

J. T. MILLER, B.Sc., F.Inst.P.

So great has been the demand for reprints of Mr. Miller's *Course in Industrial Instrument Technology* that the supply was soon exhausted, and a more convenient new edition, produced by the photo-litho process and bound in stout paper covers, is now available.

CONTENTS

I. Basic Elements or Mechanisms.
II. Diaphragms.
III. U-Tube Manometers.
IV. Flow Metering Elements for Fluids in Pipes.
V. Flow Metering Elements for Fluids in Pipes (*continued*).
VI. Measuring Instruments for Differential Flow Elements.
VII. Flow Measurement: Integration from Differential Pressure Instruments.
VIII. Area Meters: Rotameters and Flowrators.
IX. Anemometers, Electrical Flow Meters and Quantity Meters.
X. Electrical Methods.
XI. Electrical Methods (*continued*): Resistance Thermometers.
XII. Radiation Temperature Measuring Instruments.
XIII. Humidity Measurement.
XIV. Industrial Electronic Instruments for the Measurement (and control) of Temperature, Pressure, Flow, etc.
XV. Electronic Instruments (*continued*).
XVI. Automatic Control.
XVII. Automatic Control (*continued*).
XVIII. Automatic Control (*concluded*).

Price **20/-** post free

Send your order to:

UNITED TRADE PRESS LTD.
9 GOUGH SQUARE
FLEET STREET, LONDON, E.C.4

CLASSIFIED ADVERTISEMENTS

continued overleaf

British Nylon Spinners Limited

require

INSTRUMENT DESIGN DRAUGHTSMEN

Applications are invited from men aged (about) 26-45, who have had two or more years' experience as a Design Draughtsman working on light electrical, mechanical or instrument equipment.

While an H.N.C. is preferred, candidates MUST possess at least an O.N.C. in electrical or mechanical engineering or applied physics. The Company policy requires progressive application of modern techniques in this expanding industry. On a merit basis there could be opportunities to progress to works, design or experimental engineering.

The appointments are located in pleasant rural Monmouthshire; housing would not be a great difficulty and generous removal expenses are given. Additionally, the selected applicants are offered attractive conditions of service including a pension fund and a profit sharing scheme. General amenities are of a high standard. Good commencing salaries are offered, and there should be scope for financial increases on a merit basis.

Preliminary interviews may be held locally during an evening if particularly required.

Please apply in writing, quoting reference E/58 to the:—

Personnel Manager,

British Nylon Spinners Limited

Pontypool, Mon.

INSTRUMENTATION AND PROCESS CONTROL

Plans to develop and expand the activities of A.C.E. Ltd., have created interesting opportunities for engineers who have specialised in the application of instruments and controls in the process industries. We are looking for men over 30, at a salary in the range £1,300/£1,700 per annum, plus the usual benefits. The work will cover development of instrument and control schemes in association with clients, engineering of these schemes including dealing with the manufacturers, and direction of junior engineering staff and draughtsmen. Engineers capable of managing all aspects of contracts would receive special consideration. These positions provide excellent opportunities to obtain experience in a wide field of applications to different industries and of manufacturers products. The future career prospects include development in either technical or managerial spheres. Opportunities for staff to undertake work overseas occur from time to time. A.C.E. Ltd., is a subsidiary company in the John Brown organisation.

Please apply to

Mr. M. P. Atkinson, Chief Engineer

AUTOMATIC CONTROL ENGINEERING LIMITED

Roxby Place, Seagrave Road, Fulham, S.W.6. Telephone: FULham 7761

Automatically assured with A.C.E.

INSTRUMENT MAINTENANCE SUPERVISOR

required by TEXACO TRINIDAD, INC.

for service in TRINIDAD

Applicants for this position must be keen to live and work in the West Indies and should fulfil the following requirements. They should be between 25 and 30, have a technical education to O.N.C. level or better, and preferably hold the City and Guilds Final Certificate in Instrument Maintenance. A recognised apprenticeship in this subject is desirable, but five years or more practical experience of the maintenance and repair of mechanical, pneumatic and electronic instruments for temperature, pressure, flow and liquid level measurement and control in the oil or chemical industry is essential.

Starting salary will not be less than £1,425 p.a.

Texaco Trinidad, Inc. provides excellent staff amenities, including cheap accommodation for married and single men, first class clubs and facilities for sports, comprehensive medical arrangements, schooling for children up to the age of 16 and a pension scheme.

Please write with brief particulars of age, qualifications and experience to:—

The Personnel Officer,

TRINOIL (U.K.) LIMITED,

29/30, Old Burlington Street, LONDON, W.1.

CAPACITY AVAILABLE

PRECISION INSTRUMENT ENGINEERS

will manufacture

INSTRUMENTS or SUB-ASSEMBLIES

Machining and Assembly Capacity Available

Fred Ferraris (Clerkenwell) Ltd., 26 Angel Colony, London, N.18.

Telephone: Edmonton 3636-7-8.

SERVICES AVAILABLE

PRECISION ENGRAVING of Instrument Panels, Dials, Scales, Nameplates, Labels, etc., Plastic Components, "Perspex" fabrications. Stockists of "Perspex" acetate, Traffolyte, etc. Speedy deliveries on long or short runs. A.I.D. and A.R.B. approved. Leicester Engravers (Plastics) Ltd., 60 Edwyn Street, Leicester. Telephone: Leicester 58375.

MIRRORS, re-silvered or re-aluminised promptly to very high standards at moderate prices. Front or back silvering including heat-resisting silvering, or surface aluminising. New mirrors supplied. Over 50 years' experience of mirror manufacturing. GOWLLANDS LTD., Morland Road, Croydon. Telephone: Addiscombe 3011.

MACHINE ENGRAVED SCALES, Feed Dials, Panels, Labels, etc., in plastic and metal. Excellent delivery. O. H. Kampf & Co., 15a Market Square, Crewkerne, Somerset.—Telephone: Crewkerne 709.

50,000

PRECISION INSTRUMENT GEARS

of all types from stock

(now including Spiral Bevels)

Write for fully comprehensive Catalogue

The Davall Gear Company Ltd., Potters Bar, Middlesex

Telephone: Potters Bar 2382

MACHINE ENGRAVING

one off or small batches

Indexing Dials and Scales divided.

Instrument Components a Speciality.

A. RUNDLE (Upper Norwood) LTD.

Micro Works, Stoney Lane, Church Road, Upper Norwood, London, S.E.19

Telephone: LIVingstone 4682

SPINNINGS

IN ALL METALS

Hydraulic and Flow Spinning Specialising for the Electronic and Instrument Industries.

★

Hydraulic Presswork

Argonarc & Spot Welding

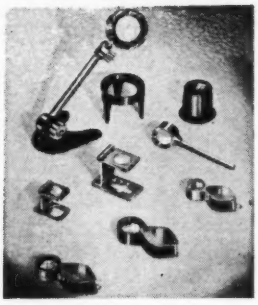
★

E. J. PURDIE & SON LTD.

49-53 CORSICA STREET, HIGHBURY, N.5.

Telephone: Canonbury 2128

When replying to any of these advertisements, please mention **INSTRUMENT PRACTICE**. It is a courtesy the advertiser always appreciates.



A Group of Magnifiers by

GOWLLANDS
LTD.
MORLAND ROAD CROYDON
SURREY ENGLAND

Precision
B.A. SCREWS *Etc.*
SPENCER COMPONENTS
5 High Street, Birmingham, 14

WATCH — INSTRUMENT — CLOCK
TOOLS and MACHINERY
Taps — Dies
Files — Pliers
Tweezers — Broaches
Drills — Pivot Steel
(.0016" & up) — (.0016" & up)
Micro-Precision Lathes and Bench Drills
Wholesale
Send for Swiss, French & British made Goods Catalogue
JOHN MORRIS (Clerkenwell) LTD.
64 Clerkenwell Road, London, E.C.1

DEVELOPMENT OF NEW PROJECTS
Designing, Drawing, Detailing Prototypes. Small quantity manufacture. Special purpose machines. Instrument work a speciality. Inventions worked out
A. RUNDLE (Upper Norwood) LTD.
Micro Works, Stoney Lane, Church Road, Upper Norwood, London, S.E.19
Enquiries and quotations invited
Telephone: LIVingstone 4682

WANTED TO PURCHASE
INSTRUMENT PRACTICE
Vols. 1 to 14 (1947 to 1960)

WM. DAWSON & SONS LTD.,
BACK ISSUES DEPT.,
16 WEST STREET,
FARNHAM, SURREY.

LABORATORY STAINLESS STEEL EQUIPMENT AND PROTOTYPES
Manufactured to customers' own requirements
BOSS
WELDING & ENGINEERING CO. LTD.
190 PENTONVILLE ROAD, LONDON, N.1
Telephone: Terminus 3598

Good Instruments deserve . . .

. . . Good Cases
Manufacturers of Leather and Substitute Cases and Covers to fit Manufacturers' own products.
WE DESIGN TO GIVE EYE APPEAL COMBINED WITH PROTECTION & USEFULNESS.
Send us your problems to solve
C. S. LINDSEY LTD.
CROWN WORKS, GODMAN ROAD, PECKHAM RYE, S.E.15
NEW CROSS 4636

THE INDUSTRIAL APPLICATION OF pH MEASUREMENT & CONTROL

by

D. Colver Nutting, M.B.E., A.R.C.S., B.Sc.

In a wide variety of industries the measurement and control of pH is a necessity. Typical examples of processes are sugar refining, water treatment, ore flotation, etc.

The author has given a concise treatment of the subject in the five articles now available as a bound set of reprints. The underlying principles are reviewed and the derivation of the pH scale explained. Methods of measurement and control are detailed, and the application to a variety of typical continuous processes is outlined. The problem of close control is dealt with by the Author.

Practical requirements during installation are specified.

Price 5/- (Post free)

UNITED TRADE PRESS LTD. 9 Gough Square, London, E.C.4

Circle 371 for further information

SWISS
RMB
MANUFACTURE

MINIATURE BALL & ROLLER BEARINGS

(A.I.D., A.R.B., and I.E.M.E Approved)

25 Years of Specialisation

The new edition of the **RMB HANDBOOK & CATALOGUE** presents with characteristic clarity and precision the current RMB range of miniature and instrument bearings.

Comprising 100 pages of information, reference material and load capacity charts, it is invaluable to every engineer concerned with instrument design.

Finely printed in four colours, their latest publication admirably sustains the prestige already gained by RMB through 25 years of pioneer development and specialisation in this field. Copies of this anniversary edition are now available, post free, to the design and purchasing offices of engineering firms on request to the sole British distributors

MINIATURE BEARINGS LTD

39 PARLIAMENT STREET, WESTMINSTER, LONDON, S.W.1.

Established 1938 *Tel:* TRAfalgar 3386 & 5188 (5 lines)

Circle 372 for further information

AIR OR GAS

VELOCITY, FLOW OR PRESSURE MEASUREMENT AND CONTROL

Velocity — 100 ft/min. to 10,000 ft/min.

Flow — 1 cc/min. to 200 cu.ft/hr.

Pressure difference — 0.01 m.m.H_2O. to 10 lb/sq. in.

All instruments have an electrical output for remote indicators, recorders and control systems.

All instruments are portable with mains or battery power supply.

Will withstand rough handling.

Easy to read pointer and dial indicators.

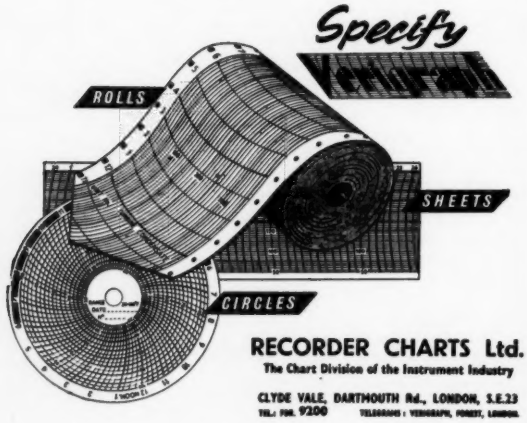
Write for leaflets to:

THE COBB-SLATER INSTRUMENT CO. LTD.,
DARLEY DALE, MATLOCK, DERBYSHIRE

RECORDING
Charts

TO MEET THE MOST EXACTING DEMANDS OF MODERN SCIENCE AND INDUSTRY

Continuous Roll, Rectangular Sheet and Circular Charts are produced in conventional ink recording papers of high stability as well as in electro-sensitive, heat-sensitive and pressure-sensitive materials.



RECORDER CHARTS Ltd.
The Chart Division of the Instrument Industry
CLYDE VALE, DARTMOUTH Rd., LONDON, S.E.23
TEL.: FOR. 9200 TELEGRAMS: TELEGRAPH, FOREST, LONDON.

WEBB'S stock everything EDDYSTONE *including . . .*

● **THE "770" SERIES**
developed for communication work but additionally fulfilling varied laboratory requirements—THE "770R" tunes 19 to 165 Mc/s—THE "770U" tunes 150 to 500 Mc/s, while the forthcoming "770S" extends the range from 500 to 1,000 Mc/s.

● **THE "880" HIGH STABILITY HF RECEIVER**
500 kc/s to 300 Mc/s in 30 ranges, with a dial setting accuracy of 1 kc/s.

● **THE "730/4"**
built to governmental specification, tunes 480 kc/s to 30 Mc/s.

And for Low-frequency Coverage the "850/2" (600 kc/s to 10 kc/s) is expected shortly.

Full specifications gladly on request from:

WEBB'S Radio
14 Soho St., Oxford St., London, W.1.
Shop hours: 9 *a.m.*—5-30 *p.m.* (*Thurs.* 7 *p.m.*), *Sats.* 9 *a.m.*—1 *p.m.*
Telephone: GERrard 2089/7308

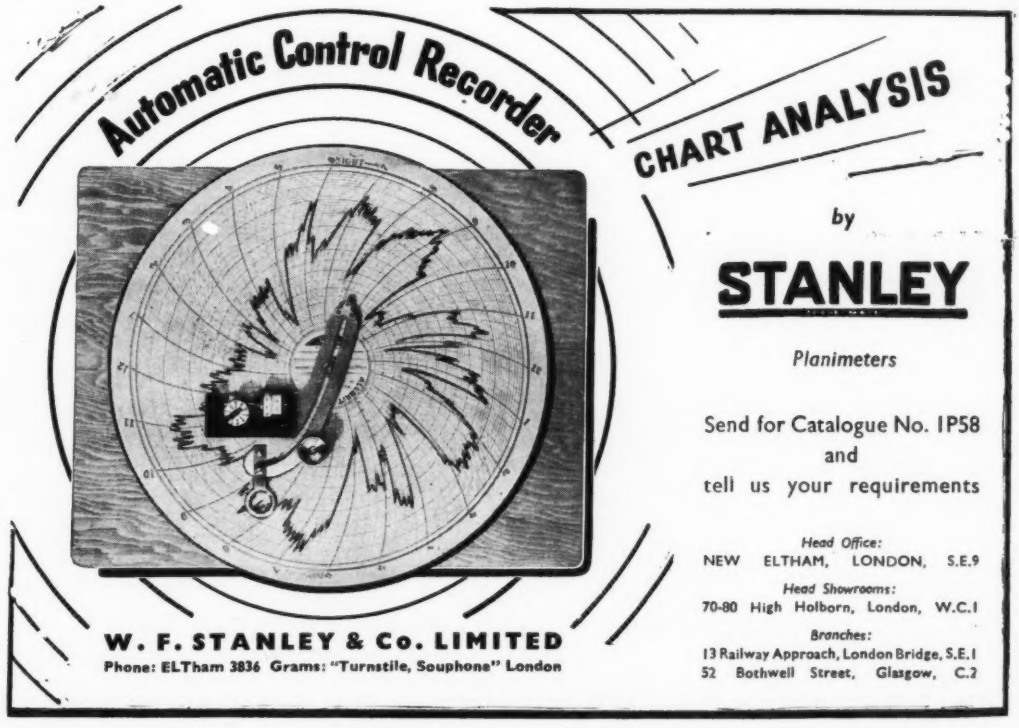
Circle 373 for further information

Circle 374 for further information

INDEX TO ADVERTISERS

	Page
Accurate Recording Instrument Co.	May
Advance Components Ltd.	669, 677, 685
A.E.I.-Birlec Ltd.	May
Alexander Controls Ltd.	684
Alto Instruments (Great Britain) Ltd.	May
Arrow Electric Switches Ltd.	May
Associated Electrical Industries Ltd.	683
Atlas Plating Works Ltd.	690
Avo Ltd.	673
Bamford & Co. Ltd., F.	May
Barrow Hepburn & Gale Ltd.	694
Bedford, A. H. & Son Ltd.	May
Beckman Instruments Ltd.	740
Bellows-Valvair Ltd.	778
B.E.N. Patents Ltd.	690
B.I.M.C.A.M.	May
Blakeborough & Sons Ltd., J.	699
Black Automatic Controls Ltd.	May
Bradley Ltd., G. & E.	May
British Rototherm Co. Ltd., The	May
British Sonceboz Co. Ltd., The	May
Budenberg Gauge Co. Ltd.	694
Cambridge Instrument Co. Ltd.	May
Cathodeon Crystals Ltd.	658
Classified Advertisements	786, 787, 788, 789
Cobb-Slater Instrument Co. Ltd., The	790
Cockburns	May
Cooke & Sons Ltd., James	May
Coulter Electronics Ltd.	682
Counting Instruments Ltd.	662
C.R.E.I. (London)	689
Crosby Valve & Engineering Co. Ltd.	May
Croydon Precision Instrument Co.	698
Datum Metal Products Ltd.	678
Davy & United Instruments Ltd.	657
Dewrance & Co. Ltd.	688
Dobbie McInnes (Electronics) Ltd.	May
Drayton Controls Ltd.	675, *Inside Back Cover*
E. & H. Filter Co. Ltd., The	783
Eddystone	May
Ekco Electronics Ltd.	780

	Page
Elcontrol Ltd.	May
Electrical Development Association	739
Electrolube Ltd.	May
Electro Methods Ltd.	693
Ellay Tubes Ltd.	778
Elliott Brothers (London) Ltd.	702
English Electric Co. Ltd., The	May
English Numbering Machines Ltd.	690
Ether Ltd.	670-671, 679
Evans Electroselenium Ltd.	687
Evershed & Vignoles Ltd.	May
Fielden Electronics Ltd.	May
Filhol Ltd., J. P.	May
Formica Ltd.	663
Firth Cleveland Instruments Ltd.	672
Fischer & Porter	684
Foster Instrument Co. Ltd.	674
Foxboro-Yoxall Ltd.	*Front Cover*
General Electric Co. Ltd., The	May
Gilbarco Ltd.	May
Gloucester Controls Ltd.	May
Goodman Ltd., George	May
Goodmans Industries Ltd.	666
Gordon & Co. Ltd., James	May
Gowllands Ltd.	789
Harwin Engineers Ltd.	May
Herbert, Ltd., Alfred	May
Hoffmann Mfg. Co. Ltd., The	660
Honeywell Controls Ltd.	*Back Cover*
Hughes International (U.K.) Ltd.	668
Hunting Engineering Ltd.	692
Imhof Ltd., Alfred	May
International Computors & Tabulators Ltd.	776
Johnson Matthey & Co. Ltd.	May
K.D.G. Instruments Ltd.	676
Kent Ltd., George	700
Ketay Ltd.	May

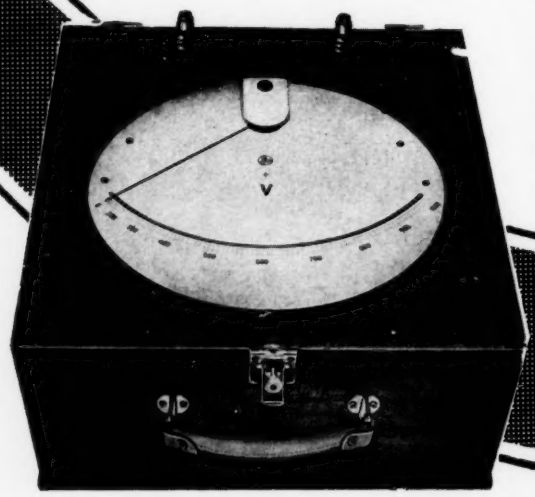


Circle **375** for further information

Circle 376 for further information

Offer Something NEW!—the Portable ELECTROSTATIC VOLTMETER

With a guarantee of overall excellence



12″ PORTABLE 1000 Volts

A first grade commercial instrument

In producing this top grade accurate instrument NALDERS have overcome the common deficiencies recognised for electrostatic instruments and have achieved first class damping—remarkably low pivot friction and high torque/weight ratio.

It indicates readings with an accuracy better than ±0.3. The instrument is completely screened to eliminate interference by external electro-magnetic fields. The input resistance is extremely high—nearly 20 million megohms.

Full details are Post Free.

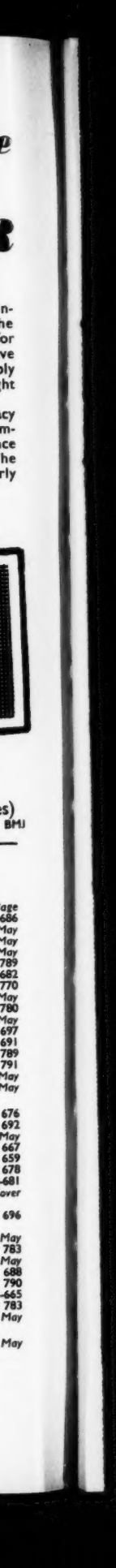
CERTIFICATED after test by The British Scientific Instrument Research Association

Send your enquiries to NALDERS

NALDER BROS. & THOMPSON LTD., Dalston Lane Works, London E.8 Telephone: CLISSOLD 2365 (4 lines)

BMJ

INDEX TO ADVERTISERS *(continued)*

	Page
Laboratory Apparatus & Materials Exhibition	784-785
Langham Thompson Ltd., J.	May
Lang Pneumatic Ltd.	May
Laurence, Scott & Electomotors Ltd.	May
Leeds & Northrup Ltd.	May
Lindsey, C. S. Ltd.	789
Londex Ltd.	May
London Electric Wire Co.	May
Lucas Ltd., Joseph	May
McMurdo Instrument Co. Ltd., The	694
Midland Silicones Ltd.	762
Miniature Bearings Co. Ltd.	790
"Monitor" Patent Safety Devices Ltd.	May
Morris (Clerkenwell) Ltd., John	789
Murex Ltd.	May
Nalder Bros. & Thompson Ltd.	792
Nash & Thompson Ltd.	May
Negretti & Zambra Ltd.	695
New Western (Engineering) Ltd.	698
Norgren, C. A. Ltd.	686
N.S.F. Ltd.	May
Plessey, Co. Ltd., The	704
Panellit Ltd.	May
Parmeko Ltd.	May
Pilot Plug Gauge Co. Ltd., The	661
Precision Rubbers Ltd.	May
Preformations Ltd.	May
Premier Screw & Repetition Co. Ltd.	May
Purdie, E. J. & Son Ltd.	788
Pyrotenax Ltd.	May
Racal Instruments Ltd.	May
Recorder Charts Ltd.	790
Rotameter Manufacturing Co. Ltd.	May
Rundle, A. (Upper Norwood) Ltd.	788, 789
Salford Electrical Instruments Ltd.	686
Sanders (Electronics) Ltd. W. H.	May
Sangamo Weston Ltd.	May
Savage Transformers Ltd.	May
Secon Metals Corporation	789
Servomex Controls Ltd.	682
S. E. Laboratories Ltd.	770
Sifam Electrical Instruments Co. Ltd.	May
Simplifix Couplings Ltd.	780
Sigma Instruments Co. Ltd.	May
Smiths Industrial Division	697
Smiths Aviation Disivion	691
Spencer Components	789
Stanley, W. F. & Co. Ltd.	791
Stephens Ltd., Henry C.	May
Stratton & Co. Ltd.	May
Telcon Metals Ltd.	676
Teledictor Ltd.	692
Telephone Manufacturing Co. Ltd.	May
Thomas Industrial Automation Ltd.	667
Thompson Instrument Co. Ltd., John	659
Tinsley & Co. Ltd., H.	678
Transitron Electronic Ltd.	680-681
Turner, Ernest, Electrical Instruments Ltd.	Inside Front Cover
United Trade Press Ltd.	696
Wade Couplings Ltd.	May
Wadsworth & Co. Ltd., Leonard	783
Walker, Crosweller & Co. Ltd.	May
Wallace & Tiernan	688
Webb's Radio Ltd.	790
Westool Ltd.	664-665
Whilems Ltd., C. J.	783
Woodhill Engineering Co. Ltd.	May
Zeal Ltd., G. H.	May

Published by the Proprietors, United Trade Press Ltd., 9 Gough Square, Fleet Street, London, E.C.4, and printed by Herald Printing Works, York and London. Registered for transmission by Magazine Post to Canada. Annual subscription rate 50/- to be sent direct to United Trade Press Ltd., 9 Gough Square, Fleet Street London. E.C.4, England